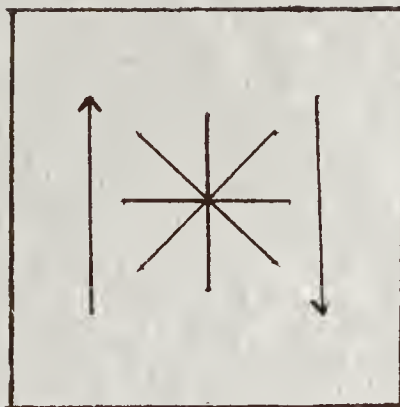
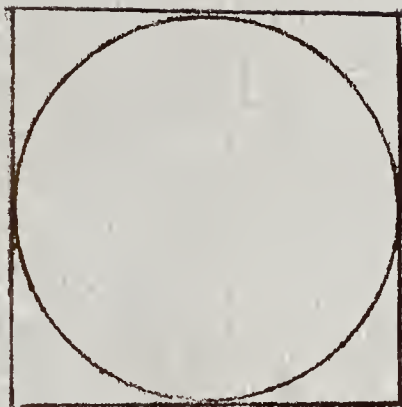


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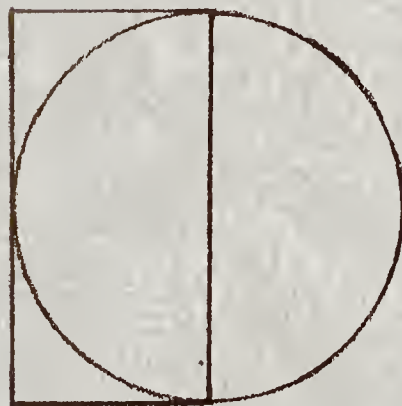


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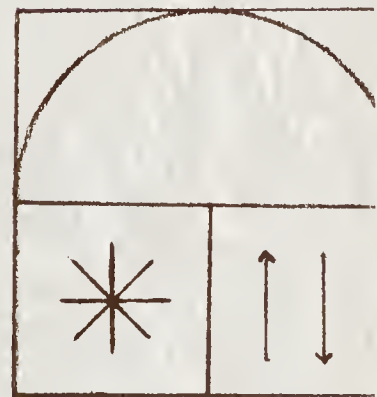
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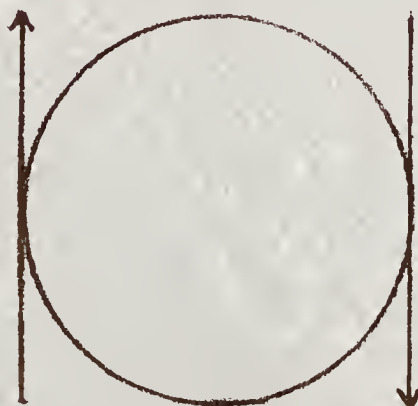
ENVIRONMENTAL SITE PERMIT SYSTEM



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A SUMMARY OF THE ENVIRONMENTAL SITE PERMIT SYSTEM

for the

State of Montana

History

In 1969, George Darrow, Chairman of the Environmental Health Planning Committee of the Comprehensive Health Planning Council, first suggested that the concept of a site permit system be explored. Robert Johnson, Director of Comprehensive Health Planning for the State Department of Health approached, among others, some members of the University of Montana faculty in December, 1969. In March of 1970, Chris Field of the U.M. Geography Department, proposed a site permit feasibility study. This proposal, much modified, became, in October of 1970, the basis of a cost sharing contract between the University of Montana and the State Department of Health. Although the project was to have been finished at the end of September, 1971, a number of circumstances intervened to delay completion until January, 1972.

This Environmental Site Permit System (ESPS) is the product of many minds. The principal co-authors of important sections of this system are Chris Field, William D. Tomlinson, Melvin Thornton, Kevin Dwyer, and William Mahoney. Many others, unnamed in this summary, have contributed. Principal responsibility, however, rests with Chris Field.

The Idea

For all its seeming public complexity, the methodology of the system proposed consists of ranking, indexing, and evaluation methods that have already been used for several different purposes. Except, perhaps, for the central idea, there is little in the ESPS that is radically new. That the allocation of space should be controlled, and that such regulation should be based on the environmental qualities and characteristics inseparable from that space, may seem radical to some and obvious to others. In fact of practice, man has always been allocating land space by intermeshing of the economic, social and value systems. This ESPS proposal makes it possible to add consideration of environmental consequences to the mix of factors that would already be present in any location choice.

Why an Environmental Site Permit System?

Confused rapid urban growth and attendant social problems in other parts of this country is forcing the nation into a revolution in attitudes towards the physical environment. An economy keyed to abundance is linked with an unprecedented technical mobility in the creation of new kinds of spatial options. Out of these

new perceptions arise the impressive forecasts for "recreational" spending, and various plans for urban re-development, dispersed model cities and recreational subdivisions. In today's America, a wide-spread concern for the environment becomes personally translated into consumption as extension of the middle-class dream. People are prepared to exercise mobility and use land in search of a quality of living not now found in the decaying urban centers or the shabby traffic-bound bedroom suburbs. These perceived possibilities lie behind the dramatic rise of "amenities" as a factor in industrial location. If we retrospectively assess the urban-industrial development of the nation during the last half century, it becomes obvious that some mistakes have been made. Rich soils of agricultural valleys have been transformed into urban monstrosities so large that their inhabitants strangle in fear, smog and frustration. Whole industries move from one coast to another as people search for places where their vision of quality living might be fulfilled. As suburbs and industries grow, restrained only by a profit-now relationship to the future, much land is physically wrecked. The historical and cultural identity of places vanishes into the common mediocrity of thousands of identical suburbs in which the intrinsic quality of space is sacrificed for convenience with the automobile. The treatment of land space as a commodity like corn futures or hog bellies, leads to profits for some and huge indirect social costs for the many. Land is our fundamental resource; there is no substitute. Destruction of the intrinsic qualities which give our spatial dimension its character and utility is a crime. Is it fair to steal and destroy the land we borrow from our children?

Why Montana?

Once an economic liability in terms of transport costs, the great western spaces are now valuable, desirable, and becoming scarce. The "Big Sky Country" slogan is truly appealing. Its implications of quality and amenity could form the basis for at least a 50 year forward leap on history, if we avoid the developmental mistakes of Kentucky, New Jersey, or California. Let Montana have a style, be unique, have an identity. What is needed is an emphasis on the active life, western style, with an environment to suit. Spaces uncluttered by sprawling smoggy suburbs; spreads of grass and trees opened to the shining mountains should be our image. The landscapes we have are unique to the world. Ours to preserve by an historical chance, these spaces will prove to be Montana's great basic resource when the mines are exhausted and the timber cut. Our advantage over other places is that now, with a little care, some planning, and a modest limitation on the traditional desire to do as we please to the land, we can enjoy and profitably use these spaces indefinitely.

Basic Assumptions

In Montana, as elsewhere, it is axiomatic that the man-environment system cannot be considered apart from the whole terrestrial ecosystem. Although the workings of our terrestrial habitat are not fully understood, it is clear that the biosphere consists of a complex network of interrelationships so tightly

woven together that a disturbance in one sector may well spread change, wave-like, into all parts of the world. Therefore, we in Montana cannot escape the ecological consequences of the least of our activities, especially on a more intimate scale. Rapid developmental changes in modern industrial systems, surging demands for goods, and mobile populations seeking amenities, will inevitably invade Montana. It is clear that much present environmental degradation is caused by people in enterprises, institutions, and agencies devoid of a sense of either local or regional identity and responsibility.

Although we are finally becoming aware that rapid growth of industrial societies produces environmental conditions which greatly threaten the well-being of man and other living organisms, we also find our governmental and economic institutions inadequately designed to cope with this newly perceived threat. No matter how belated, the realization that the world has limits must now find direct application in innovative policies of restraint if we are to avoid destruction of that network of biotic resources which ultimately sustains us.

One of the obvious assumptions then, is that if the amount of development cannot be controlled, surely some of its environmental impact can be reduced by deflection of the location choices to those sites least likely to suffer disastrous environmental consequences.

Considered, thoughtful restraint in the allocation of space is absolutely essential to the preservation of landscape quality or character.

The ESPS scheme described here is thought useful as an evolutionary stop-gap measure, until such time as economic and political systems stimulate development of the technology needed to implement more permanent solutions such as closed-systems cycling. The tradeoff "carrot" that could motivate this kind of technologic change might well be the freedom of location.

Feasibility

This is more than a feasibility study. Potential systems of site analysis had to be conceived, structured, and speculatively operated. The only known precedent was that of the State of Maine; this system was judged to be cumbersome and inapplicable to the series of small developmental decisions which accumulatively make such large impacts.

The amount and quality of information needed for scientifically credible, systematic, comparative evaluations presents the most difficult limitation. The kinds of information needed to make the basic evaluations of ecosystem energy flow and potential are still rare, especially in Montana. It was felt that the information requirements of modern systems analysis would be slow in developing, and impossible to require of either agency or enterprise in the initial stages of site permit implementation. Therefore, the measurements, comparisons, and index scores in this system represent principles and the availability of information as much as anything else. It is hoped that this ESPS, or a similar one,

would provide a demand for ecosystem studies of various kinds, resulting in generation of the necessary data and in improved evaluative mechanisms for predicting human impact.

This system works with parameters whose functional relationships are largely intuitive, or still imprecisely defined. Their adoption reflects a sense of urgency that has played against the uncertainty of absolute scientific accuracy as well as political feasibility during this last year. This ESPS is thought to represent a compromise that achieves a margin of both feasibility and effectiveness. It could prove to be an important link in a series of instruments and policies devoted to the protection of environmental quality and resource options.

Methodology

Any evaluative methodology must change as does the quality of information or the values that society places on aspects of environment. A greater sophistication of analysis will become possible through the operation of the system. The process of operating a site permit system is bound to generate knowledge as well as dispute. Both could stimulate greater commitment to fact finding and identification of "the public interest in the environment".

In spite of the apparent complexity, detachment, or objectivization that is achieved by fragmenting a series of decisions into smaller ones, it must be recognized that site permit judgments must ultimately be made by informed men of good will. No administrative mechanism or institution can substitute for individual integrity. This kind of environmental evaluation system is designed to help make value judgments which, because of their importance, border on being moral. Any institution in the position of making decisions that involve moral alternatives of biological importance must be deliberately responsive to public opinion if it is to survive or have its judgments respected. Such an institution must, therefore, have independence of scientific judgment and political security to weather the conflicts of narrow interest. There is, therefore, much emphasis on information and process value in the ESPS. An elaborate effort is made to require the inclusion of community involvement in the site permit process. It should contribute strongly to the development of local participation in the making public of those environmental location decisions which used to be privately or surreptitiously imposed. The feasibility of the ESPS depends to a great degree on honest attempts to find the best and most relevant information about the context of newly proposed enterprises.

The burden of information procurement required by this simple ESPS may well be greater than most small enterprises are capable of providing. The demand of this system has already been reduced to a minimum. Effective implementation will require assistance from many sources. Few of today's small enterprises, even if they have a strong sense of environmental responsibility, know what to do. It is likely that few of them feel that they can afford comprehensive, detailed, studies. Even fewer, we suppose, desire

to be obliged to carefully attempt a prediction of their impact. The ESPS evaluation process, nevertheless, does make an important start in demonstrating to the public a feasible and effective means. In the process of completing an evaluation, at least some of the important questions are asked. Without trying to ask vital environmental questions, without attempting to get some of the answers, there may be no way to prevent a gradual decline in the qualities of our habitat. A slow drift in which we perceive the end but are too paralyzed to act, is the essential ingredient of tragedy.

THE ENVIRONMENTAL SITE PERMIT SYSTEM

The system is presented in five sections.

1. Administrative.

Entry: As can be seen from the attached Administrative Flow Chart, a decision to locate, to choose a site and develop an enterprise, must come from the society at large. With the knowledge that the State of Montana requires a site permit, the locating enterprise conducts a self-evaluation (using the system included here under points 2-5) and mails the completed self-evaluation to the Site Permit Agency. In order to take cognisance of the accumulative effect of small actions, as well as to develop a broad sense of citizen participation, it is thought that entry into the system should be fairly comprehensive. "Any enterprise intending to alter, premanently use, or modify Montana space must evaluate itself, using the ESPS format procedure and index scores." Together with the information required by the method of evaluation, the reported scores constitute an application for a site permit when received by the administrating agency.

Agency responsibility: The agency charged with administering a system of environmental site permits must;

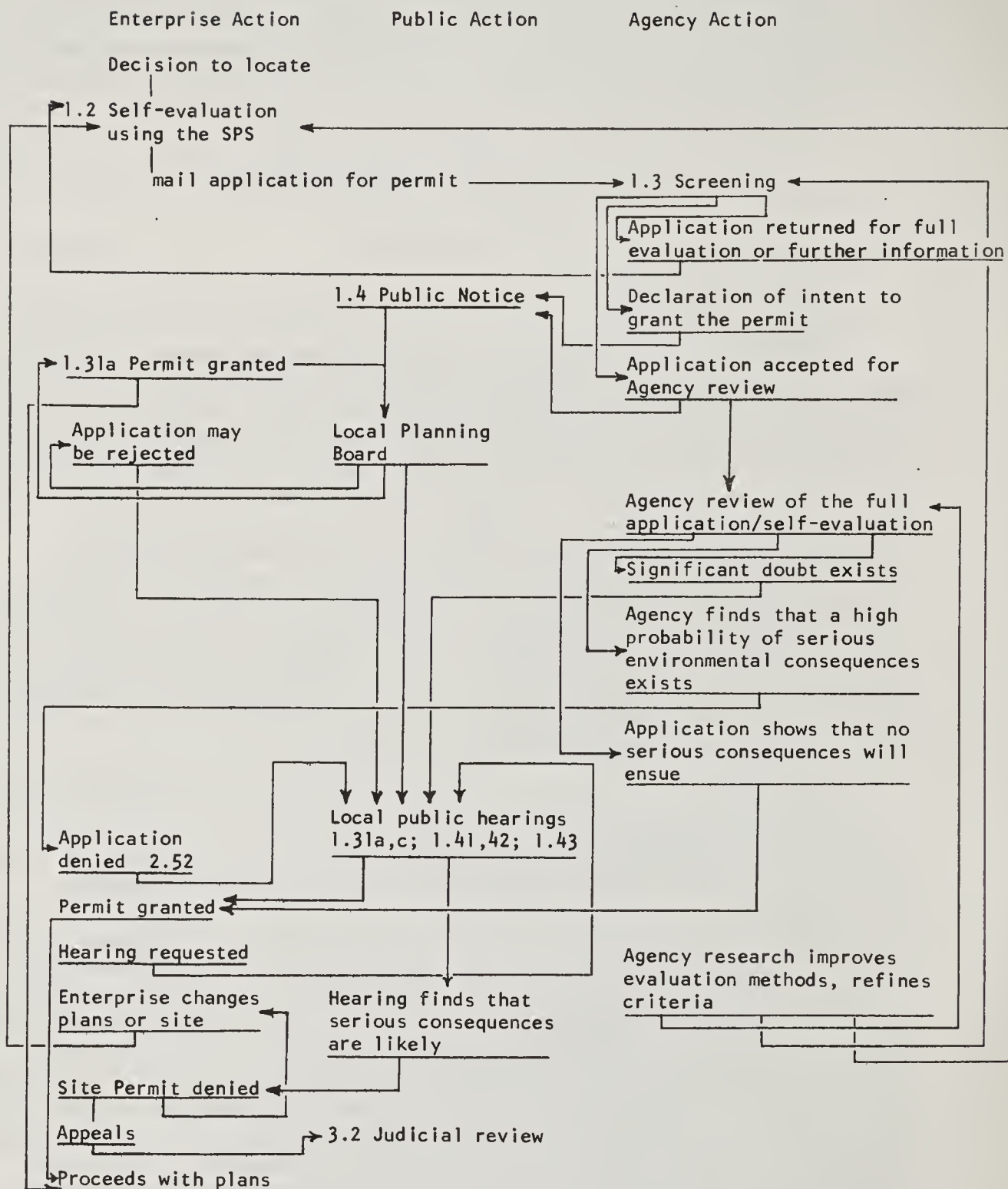
a) seek to preserve ecosystem integrity as a foundation for human health and the successful functioning of social and economic systems;

b) maintain a process to evaluate and regulate the allocation of space in recognition of the dynamic interacting relationships between environmental processes, human needs and preceptions (in such regulatory evaluations the agency and its hearing boards must make decisions in conformity with principles of sound land and resource use such as are expressed in the sections of this report that deal with land, air, water and social cost evaluation);

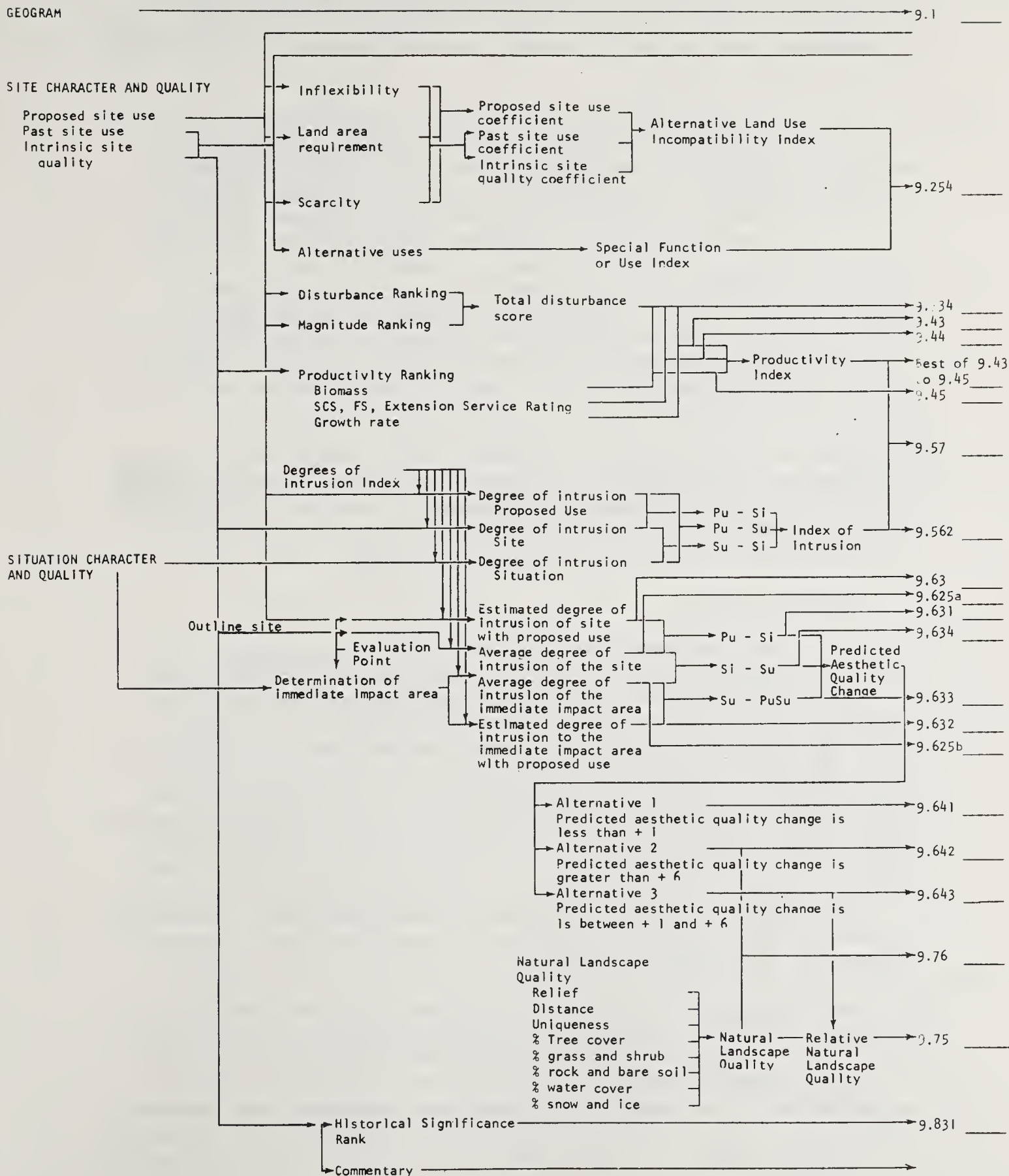
c) consider the consequences of proposed development and land/use changes in relationship to the surrounding physical, social and economic contexts, making decisions, when necessary, on a basis other than of monetary value so as to secure the preservation of: aesthetic character, historic identity, and long-term resource-use alternatives of the land;

d) attempt to predict and make known the environmental consequences of proposed developments in relationship to the locations chosen by public or private enterprise;

ADMINISTRATIVE FLOWCHART



LAND FLOWCHART



- e) develop, improve, and implement systematic methods of evaluation capable of detecting or predicting those ecologic relationships which extend the consequences of development to a wider or more general environmental degradation;
- f) make public such findings and information as may flow from the operation of the system or from the research intended to improve the process; and
- g) maintain as open public records all applications, attachments and evaluation reports.

Public participation: In the evaluation of an application for a permit, the agency, for reasons of efficiency, obviously must exclude a substantial number of applications as inconsequential. Therefore, a preliminary screening is introduced prior to the full and complex review. Under both circumstances, however, public notification has been made an important requirement of the system in order to assure that the process is conducted openly. Local planning boards are involved by veto power over a site permit. They may not, however, grant a site permit over the objections of a State-level agency. Conflicts and indecision are resolvable at local administrative public hearings, as is provided under the administrative procedures act. A judicial review would, of course, be available to the public as well as to the enterprise.

Authority: It should be noted that this administrative system provides for permit denial. The limits of authority to be granted to a permitting agency must be seriously considered. The power to procure information and review the evaluation process, along with thorough public exposure, may well be sufficient.

2. Land Evaluation.

Follow the Flowchart: The first part of the application, the "Geogram", contains a basic environmental inventory of the site. It is designed so as to facilitate future computerization. The evaluations which follow are based on self-description of the characteristics of the proposed enterprise and the particular site to be developed. Land use changes are ranked according to the inflexibility of their environmental quality requirements, land area requirements, and scarcity in Montana. The changes in proposed land use are then ranked in comparison and given an index score. Special circumstances may also be introduced to alter this index.

A disturbance score is obtained by ranking the kind of surface disturbance in six categories against a magnitude of disturbance scale to produce another index.

Three methods of roughly estimating biologic productivity are included for weighting the significance of the total disturbance.

Since the quality of a particular site is often very much a consequence of the interacting elements of the particular surrounding situation in which it is to be found, as equally is the impact of site development of significance to its surroundings, two methods

of attempting to evaluate these relationships are included. An internal reference series of descriptions, entitled "Degrees of Intrusion" have been devised, each with an index number (1-10). The evaluator must find the description that best fits his site, the surroundings, and the proposed use or condition of that site after development. The indices of modification of the site and situation are subtracted in such a way as to give an overall index to the development. The index may reflect improvement of a site or situation.

The same set of descriptive references, the Degrees of Intrusion Indices, are used again in an attempt to predict the change in aesthetic quality that would ensue from a development. If the change in aesthetic quality is thought to be significant, an evaluation of the natural landscape, based on the physical features, is used to weight that aesthetic quality change.

No way was found to systematically evaluate all the possibilities of historic or archeologic significance that can be associated with a site. A basic descriptive ranking was included, but with a special provision for deliberate commentary on that question. All index scores are summed for convenience in screening.

In Section 10 of the Land Evaluation, some special problems are considered. It is impossible for any system to consistently predict the direction and possible impact of new technology, therefore, the ESPS must remain open and flexible to such kinds of changes. Some commentary on the possibilities of special evaluation for nuclear power plants is attached.

3. Aerometric Evaluation.

Note the following commentaries to the Flowchart: In any attempt to minimize air pollution problems by site selection, the climate of the location must be considered. The principle is that any proposed enterprise or community activity must consider good air sanitation as one of the first costs of doing business. This portion of the site permit system is not intended to encourage or condone the practice of aerial waste disposal, either by dilution or by dispersion at any location. Rather, the system is designed to assess the proportional costs attributable to "atmospheric and related parameters" given the particular levels of air cleaning proposed by an enterprise. Indexing and scoring in relation of site to enterprise is intended to show the citizen-enterpriser how to estimate the consequences of his action and thereby provide him with a rationale for alternative site choice. The system requires the enterpriser to fully disclose and guarantee the accuracy of the information about his potential emissions. Although the evaluation of the potential for dispersal would seem to indicate a desire to deflect emissions towards high potential sites, it must also be noted that nothing in the permit system could conceivably be interpreted as intending to supersede the standards, rules and regulations now in effect.

4. The Hydrologic Data Index.

The Hydrologic Data Index is designed to function as a diagnostic model for the evaluation of interactions between site and enterprise as they relate to water quality and hydrologic function. It acts both as a guide and is a statement of policy. It too is intended to function in addition to present policies, rules, regulations and standards adopted in response to statutory requirement of current water related laws in the state. The purpose of the water evaluation in the system is 1) to prevent the contamination or alteration in physical property of water as a result of its utilization by either an enterprise or a community activity; 2) to work to eliminate present sources contributing to the contamination or alteration of the physical property of water.

5. Social Costs.

In the Site Permit System social costs are defined as those consequences of enterprise location which cannot be absorbed by the community without disruption. Disruption is basically an increase in or a cause of community dysfunction. Although not the cause of all community problems, rapid population change is one of the most apparent and easily measured indicators of potential community disruption. Population changes are immediately reflected in the demands placed upon the services provided by the community. For example: an increase in the number of children places a greater burden on the school system. Increased use of and demand for roads results in greater maintenance and construction cost. News of potential jobs may result in further in-migration which may then cause an increase in welfare load.

It is felt that indicators of disruption potential reflect in a most general and straight-forward manner the possibility of an inadequate matching between enterprise, site, and the community situation. Potential disruption can be indicated by:

- 1) the amount of population growth attributable to the location of an enterprise in the community, in relation to the size of that community;
- 2) the size of the enterprise in relationship to the probable lifespan of that enterprise; and
- 3) the quantity of public services utilized by the enterprise in relationship to the ability of the service(s) to absorb the increase in use without expansion of presently available facilities (i.e., services used in relationship to the unused capacity of these services).

These parameters are not measured in dollar terms. Relative indexing of disruption is accomplished by the assignment of points to percentage figures generated from the above-mentioned parameters.

Conclusion

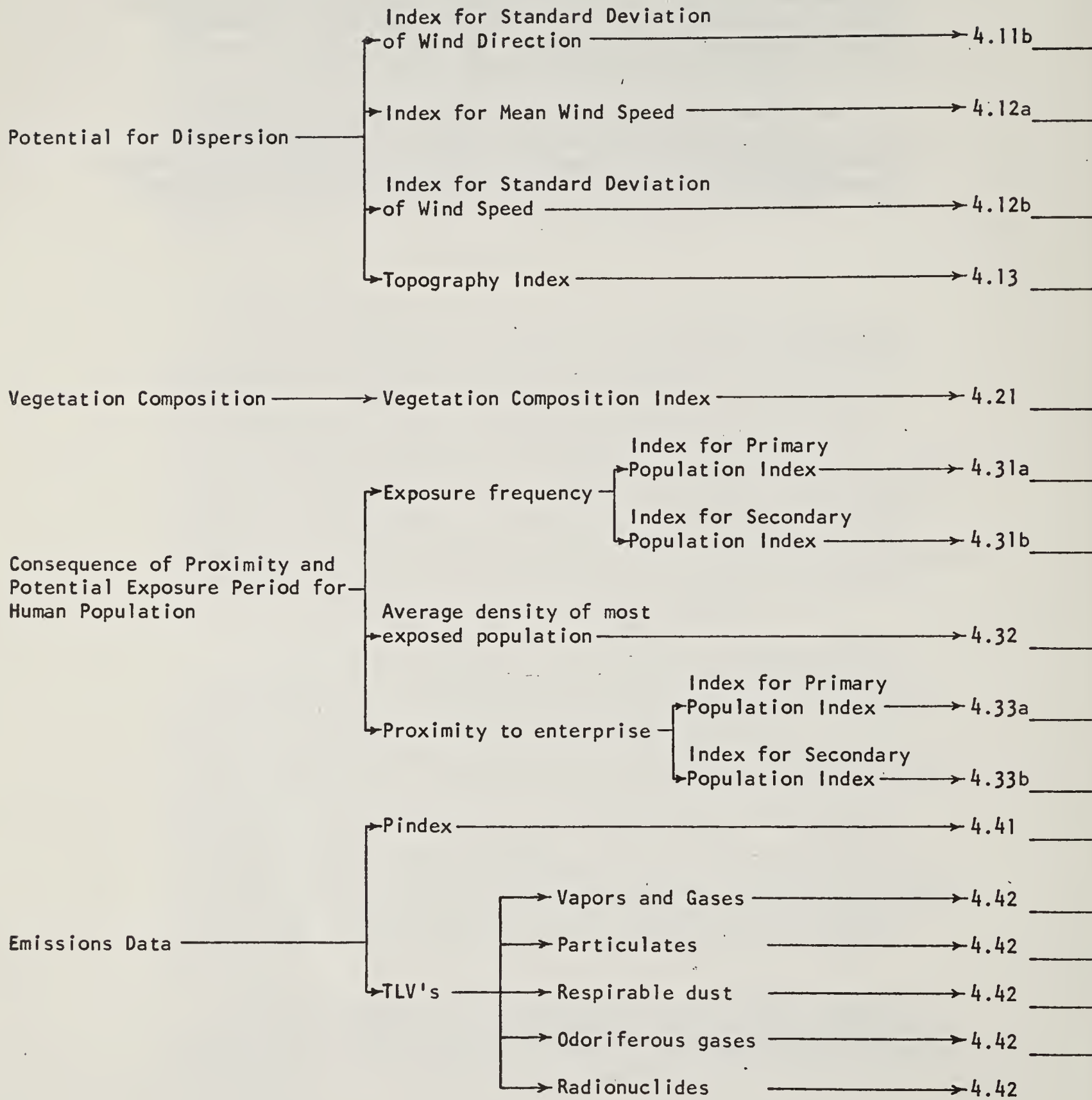
The index sums for each section clearly show where the possible problems lie. A decision to do an agency field check may be stimulated by discrepancies between the data on the Geogram and

any one of the sections. Experience will count heavily.

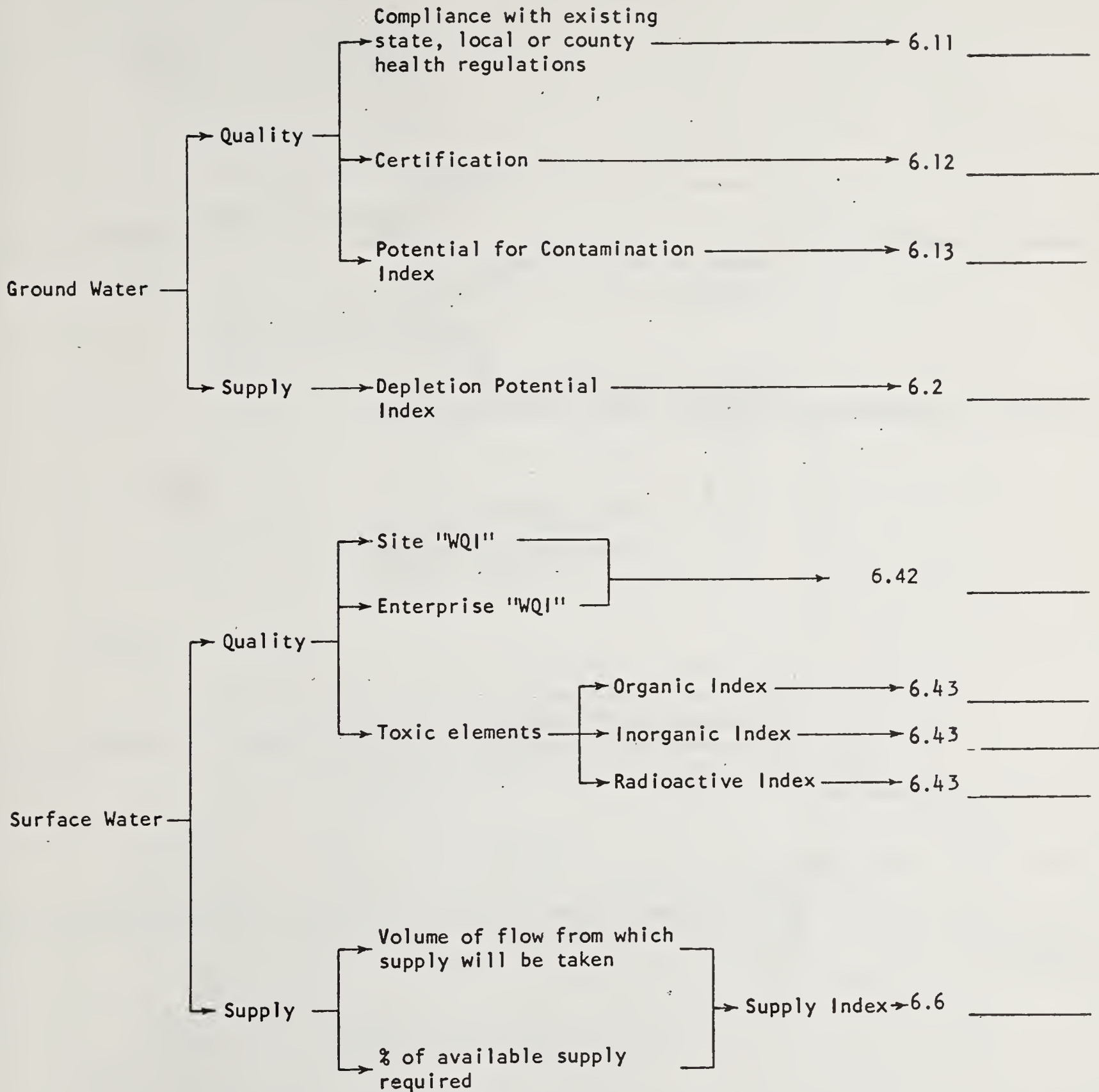
An initial operating recommendation is that the permit be routinely granted if the application shows no more than a 40% of the possible score on any one section, with a total score below 30% of that possible. Permits should be denied or, at least, sent to a hearing if the score in any one section is over 60%, or if the total score is over 50% of the possible.

No matter what the cutting points on the scores might be, it must be remembered that the major value of the system lies in the process, for in that way questions can be asked and alternatives considered before either minds or enterprises are set in concrete.

AEROMETRIC DATA FLOWCHART



HYDROLOGIC FLOWCHART



SOCIAL COSTS FLOWCHART

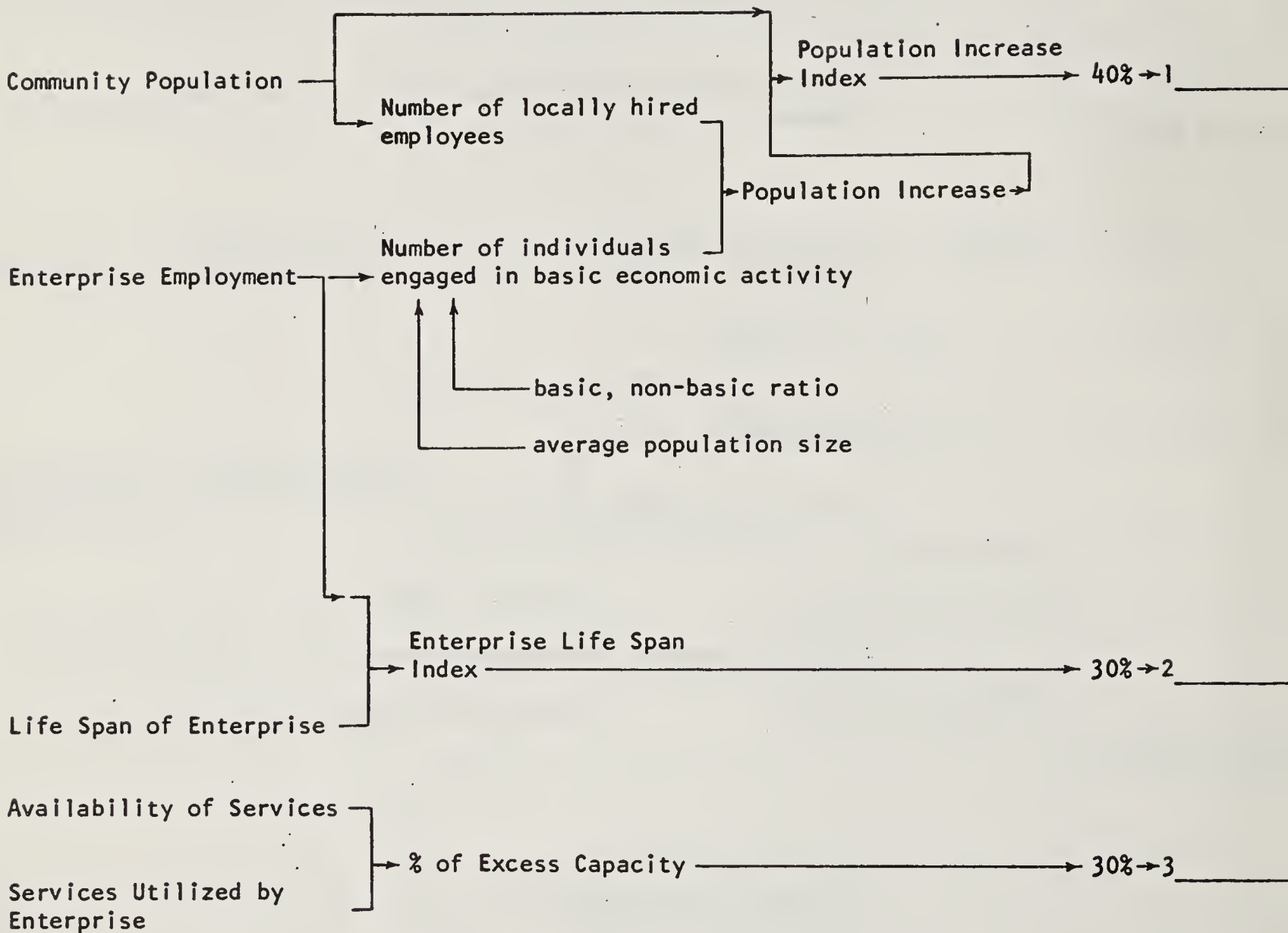


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PREFACE

Since every idea has a history, it would be well to outline some of the background of this effort. George Darrow, Chairman of the Committee on Environmental Health Planning of the Comprehensive Health Planning Advisory Council, first suggested that the concept of a site permit system be explored. Robert Johnson, Director of Comprehensive Health Planning for the State Department of Health approached, among others, some members of the University of Montana faculty in December of 1969. In March of 1970 a proposal to conduct a feasibility study was made by Chris Field of the Geography Department. This proposal, eventually much modified, resulted in a \$22,430 cost sharing contract between the University of Montana and the State Department of Health for a feasibility study in October 1970. Although the project was to be finished in September of 1971, a number of circumstances intervened to delay completion until January 1972.

This was more than a feasibility study in the strict sense of the word. At the time the only known site permit program was that of the State of Maine. That system applied only to operations which would "significantly affect" areas over twenty acres in size. The questionnaire methodology seemed inappropriate to use for smaller sites and enterprises. It was necessary to first create a system concept and then, while perfecting it, continuously keep the question of feasibility in mind.

The fifteen month project was conducted as a floating seminar in which students from many disciplines had opportunity to grapple with problems, articulate environmental goals, and use their imaginations in creative, but applied, work. It is more or less unanimously agreed that the experience was educationally rewarding, albeit difficult and often frustrating. The directed problem-solving approach outside customary disciplinary boundaries proved exceptionally valuable, since no "expert" solutions for the clutch of problems posed by the ESPS idea existed.

The ESPS methodology presented here, is, for all its seeming public complexity, a simple patchwork of ranking, indexing, and evaluation methods used by many institutions for many different purposes. There is little in it that is radically new, except, perhaps for the central idea. That space allocation could be controlled, and that such regulation should be based on the environmental qualities inseparable from that space may seem radical to some and obvious to others. In fact, man has always been allocating land-space in relation to the intermeshing of economic, social and value systems. This proposal merely adds the dimension of environmental consequences to the mix of factors already resident in any location choice.

This Environmental Site Permit System (ESPS) is the product of many minds. It was put together in the University of Montana Geography Department by Chris Field, William D. Tomlinson, Melvin Thornton, Kevin Dwyer, and William Mahoney. All are co-authors of important sections of the system and this report.

Development of this Site Permit System would not have been possible without the active participation, tolerance, even, sympathy of numerous colleagues. The principal participants who joined the Site Permit Group at one time or another , were: Peggy Crouch, Sue Baldwin, John Eaton, Robert Fletcher, Robert A. Herendeen, Karen Kuenning, William Leitch, William MacAfee, Mary Jo Stephen, and James Moore. Good advice came from many sources, some of them perhaps unconscious contributors. During this last year we were fortunate to have had Meridan Bennett, George Darrow, Daniel Luten, John Goers, and Benjamin Wake give us the benefit of their points of view. The encouragement and patient support of Ted Clack and Bob Johnson of CHP made this whole effort possible.

The report might never have been finished without the organizational skills of Christy Bixby, Genie Brier, Joyce Eaton, and Sandee Schmidt.

Missoula, January 1972

INTRODUCTION

This nation is belatedly coming to an appreciation of the need for comprehensive planning of the sort that takes a positive direction, working seriously to define and secure a desirable future.

Introduction

National trends

Dissatisfaction with confused rapid urban growth and attendant social problems is leading to a revolution in attitudes toward physical environment. An economy keyed to "abundance" is linked with an unprecedented technical mobility in the creation of new kinds of spatial options. Out of these new perceptions arise the impressive forecasts for "recreational" spending, ambitious plans for urban redevelopment, model cities or recreational sub-division. These new ideas lie behind the dramatic rise of "amenities" as a factor in industrial location. There is, in today's America, a widespread concern for the environment, which, translated into a personal extensions of the middle-class dream, prepares us to again exercise mobility in search of a quality of living not found in the decaying urban centers or shabby traffic-bound bedroom suburbs.

Montana

Once an economic liability in terms of transport costs, the great Western spaces are now valuable, desirable, and becoming scarce. Montana does not have a soft and balmy climate. In the contemporary fashion it is not likely that there will be many retirement cities. The "Big Sky Country" slogan is apt. Its implications form the basis for at least a fifty-year forward leap if we can but learn from the developmental mistakes of California and Hawaii. Let Montana have style, be unique, have an identity. What is needed is an emphasis on the active life, western style. Spaces uncluttered by sprawling suburbs; spreads of grass and trees open to the shining mountains should be our image. These landscapes are unique to the world. Ours to preserve by historical chance, these spaces will prove to be Montana's great basic resource when the mines are exhausted and the forests plundered. Our advantage now, is that with a little care, some planning, and a modest limitation of the traditional desire to do as we damn well please to the land, we can enjoy and profitably use these spaces indefinitely.

How do we use space?

Considered, thoughtful restraint in the allocation of space is absolutely essential to the preservation of landscape quality. If we retrospectively assess the urban and industrial development of this nation (or this state) in the last half a century, it becomes obvious that some mistakes have been made. The errors become more obvious if they are held up any long-term vision of a possible future for men no longer able to seek new earthly frontiers. We have wasted. Rich soils of agricultural valleys have been transformed into urban monstrosities so large that their people are strangling in fear, smog and frustration. Whole industries moved from one coast to another as people searched for places where their vision of quality living might have had a chance of fulfillment. As suburbs and industries grew,

restrained only by a profit-now relationship to the future of the environment, much land was physically wrecked. The identity of places vanished into the common mediocrity of ten thousand similar towns in which the qualities of spaces were sacrificed to the convenience of the automobile. The treatment of land as a commodity like corn futures or hog bellies led to profits for some, and huge indirect social costs for many.

Land so ruined in biologic productivity is a mortgage on the future of humanity. It is futile to declare ourselves independent of earth, it is foolish to wish the laws of biology declared unconstitutional. In relation to the possible future of the human race, in relation to the real world of our grandchildren, this planet is small and we cannot afford to waste. The destruction of space, or the intrinsic qualities of the environment that give the dimension its character and utility, is a crime against the future. To steal and destroy the land we borrow from our children is immoral.

Biology and change

It has taken some 2 billion years for the life processes to create the millions of different organisms which now inhabit the earth. This enormous time span is not to be taken lightly when contrasted with the brief history of our own single species. In general, man's influence on the immense diversity of earth has been to reduce it in return for greater production of fewer crops. Our historical experience has demonstrated that an increase of cultural and economic quantity was made at the expense of biotic resources. The tragic lament of a few decades past, "where have the buffalo gone?" can now be echoed for clean air, water, prairie, ponderosa pine forest and natural beauty.

We recognize clearly that change, even loss of species, is not an extraordinary ecological event. Rather, change is near the essence of ecology. The orderly but incompletely predictable process of change termed "succession" characterizes the dynamic state of ecosystems. But as Eugene P. Odum (Science, Vol. 164, 18 April 1969) puts it, "The overall strategy is...directed toward achieving as large and diverse an organic structure as is possible within the limits set by the available energy input and the prevailing physical conditions of existence."

The question raised by Odum (ibid.) "is variety only the spice of life, or is it a necessity for the long life of the total ecosystem comprising man and nature?" has not been answered with finality, but there is reason to believe that it is much more than spice. A complex community acts so as to prevent wildly oscillating change by establishing a more orderly, dampened, succession of changes.

Since the variety of the untrammelled and undomesticated ecosystem is essentially unrepairable once destroyed or simplified by man, the wise action is to preserve it. The hard-earned wisdom of childhood that we should not take apart things which we cannot put together again was never more pertinent. "Only God can make a tree," wrote Joyce Kilmer, and all our sophisticated systems analyses put together cannot make a forest.

Operating assumptions

We take it as axiomatic that the man-environment system (in Montana as elsewhere) cannot be considered apart from the whole terrestrial ecosystem. Although the workings of our terrestrial habitat are not fully understood, it is clear that the biosphere consists of a complex network of interrelationships so tightly woven together that a disturbance in one sector may well spread change, wave-like, into all parts of the world. We cannot, therefore, escape the ecological consequences of the least of our activities, especially on a more intimate scale. The rapid developmental changes in modern industrial systems, exploding populations, and surging demands for goods have led to an ever-increasing alteration of the world's vegetative cover. First by plow, cow and ax, now this is done by bulldozers and institutions without a sense of either local or regional identity or responsibility.

Those who share this perception of danger to life on earth must sharpen their awareness, communicate their understanding and knowledge, and attempt to develop, out of a concern for the survival and improvement of civilized life, an ethic which will make possible the implementation of serious and effective regional, national, and world-wide environmental protection policies.

Need for restraint

We have buried croplands beneath highways and cities, stripped even the remotest mountains of ores and fuels, and irresponsibly polluted the waters and air. Steadily growing numbers of Third-World people are committing themselves to industrialization, thus taxing already scarce natural resources more and more. While the inconsistency of advocating restraint in resource utilization from the heights of consumptive affluence puts the Western World in a difficult moral position, it is clear that without translation of these convictions into social self-regulation on a world-wide, as well as local scale, humanity can have little hope for an extended future.

Not only does our rapid rate of environmental changing threaten to overcome the adaptative potential of slow evolutionary mechanisms--with consequent loss of biologic productivity--it also threatens the continuity and integrity of our civilization through alteration of our aesthetic values and the purposes of our economic and social institutions.

Men are finally becoming aware that the rapid growth of industrial societies is producing environmental conditions which gravely threaten the well-being of man and all other living organisms. But however belated, the realization that the world has limits must find direct application in policies of restraint if we are to avoid destruction of that network of biotic resources which ultimately sustains us.

Collective action required

The world-wide magnitude of environmental problems may provoke feelings of impotence in the individual. This sense of inadequacy, both as to the problem and its cure, is serious, for it leads directly to political apathy and indifference to the environment. It may lead to alienation, a passion for material excess, or retreat into urban anonymity. Therefore, new measures need to be taken to facilitate expression of individual concerns through common action. Ultimately, responsibility rests on each individual, but major directions and policies must be primarily implemented by the aware and concerned through collective institutions of society.

Understanding of environmental problems and initiation of trial solutions demands a major effort that cannot be placed exclusively in the schools, local government, the academy, or state agencies. One effective and immediately responsive route to environmental action is through the agencies of state government. State agencies, if both theoretically and actually responsive to public feelings and attitudes can act to initiate policies that restrain environmental abuse.

The initiation of a site permit system within the context of a state government, would have, theoretically at least, very great potential for translation of environmental concern into environmental protection.

The study

This was more than a feasibility study. Potential systems of site analysis had to be conceived, structured, and speculatively operated.* This system represents the synthesis of those devices and strategies deemed most feasible within the constraints of the desired objectives and the limitations of our abilities and knowledge. This Environmental Site Permit System, (ESPS) is thought to represent a compromise that achieves a margin of both feasibility and effectiveness.

The scheme described herein is useful as a stop-gap measure, until such time as economic and political systems and opinion stimulate and insist upon the development of the technology needed to implement more permanent solutions, such as closed system cycling. The trade-off 'carrot' motivating this kind of technologic change may well be the freedom of location.

The amount and quality of information needed for the conduct of scientifically credible, systematic comparative evaluations presents one of the most difficult limitations. Modern environmental methodologies are all developing a dependence on computerization of vast amounts of data. One serious problem is, of course, the relativeness of the degree of accuracy considered acceptable in achieving the stated

*In the following section entitled alternatives, there is some discussion of the feasibilities of other strategies.

objectives. The other is the very real fact that our knowledge about the earth and its processes is still very limited. We know that some kinds of ecologic relationships exist, but the measurement of many parameters is incomplete. Therefore, the predictability of the science is still low.

In evaluations of change and the impact of that change on local or regional environments, prediction is necessary. The kinds of information needed to make the basic evaluations of ecosystem energy flow and potential are rare anywhere and very spotty in Montana. It was felt that the information requirements of modern systems analysis would be slow in developing and impossible to require of either agency or enterprise in the initial stages of site permit implementation. Therefore, the measurements, comparisons, and index scores in this system represent principles and the availability of information as much as anything else. It is hoped that this ESPS or a similar one would provide an expression of need for ecosystem studies of various kinds, resulting in the generation of necessary data and an improved evaluative mechanism for predicting human impacts. This system works with parameters whose functional relationships are largely intuitive or are otherwise imprecisely defined. Their use reflects a sense of urgency that has played against the uncertainty of feasibility during this last year.

Feasibility

The ESPS described herein is designed to be put into use within the next four years. It seems feasible from administrative, technical, and political points of view. It could prove to be an important link in a series of instruments and policies devoted to environmental quality and resource options. We hope that it will receive serious consideration.

Considering the possible long term future of an ESPS, it seems obvious that the methodologies will change along with the quality of information and the values that are given to different aspects of environment. A greater sophistication of analysis will become possible by the operation of the system. The process is bound to generate dispute which could stimulate greater commitment to fact finding and identification of "the public interest." Even so, it must be recognized that Site Permit judgments must ultimately be made by informed men of good will. No administrative mechanism or institution can substitute for individual integrity. This kind of a system is designed to help make value judgments that, because of their importance, border on being moral. Any institution in the position of making decisions that involve moral alternatives of biological importance must be deliberately responsive to public opinion if it is to survive or have its judgments respected. Such an institution must also have independence of scientific judgment and political security to weather purely political storms of narrow interest. There is, therefore, much emphasis on information and process value in the ESPS. An elaborate effort is made to require inclusion of community involvement in the site permit process. The ESPS should contribute strongly to the development of local participation in the "making public" of those

lasting environmental decisions which used to be imposed privately or surreptitiously, even by government enterprise.

Authority and Government

The problem of how much authority is needed is difficult. Certainly, any administrative agency must be authorized to require, obtain access, and insure the accuracy of needed information. The sanction of permit denial is thought to be legally defensible and possibly useful as a device to force compliance. Under modern government process concepts, however, it may well be much better to hold such power in abeyance. There is great power inherent in the process of self-evaluation, trusting to public participation and public hearings for final decisions. The open nature of this system, with recourse, due process, and standing to contribute evidence, enhances feasibility and may make effectiveness possible irrespective of the sanctions traditionally necessary to assure compliance. There is danger to the environment, however, in perpetuation of the traditional economic aspects of political accommodation to rules and government policies of inaction.

The standard objections made about government processes are serious. Government need not stifle innovation and change by the simple tactic of bureaucratic inertia or deliberate delay in the administrative channels. The ESPS has some provisions designed to eliminate these objections. Prompt public hearings are important. Nevertheless, when environmental dangers are clearly possible but the conditions surrounding that possibility are uncertainly known, the wise action is restraint, even when produced by delay or permit denial. Most of the threatened areas, natural processes, or resources either improve or grow more valued with the passage of time. Therefore, it seemed prudent to "suspend action, pending informed opinion". In sum, it would be unlikely that an agency would need to summarily deny a permit if the process of obtaining it made the environmental implications, costs, losses, or "trade-offs" clear to the public.

In the ESPS, the authority of the people still rests with them. It does not attempt to take away their "freedom". The process and the implementing agency would help protect, but would not remove the necessity that the public remain vigilant in the protection of their environmental rights.

Implementation and data

The feasibility of the ESPS depends to a great degree on the goodwill inherent in honest attempts to find the best and most relevant information about the context of the newly proposed enterprise. One of the most difficult kinds of information to get, for example, are those relating to the capacities of localities to provide utilities and social services. Because of the common assumption that growth and expansion are intrinsically good, the people who manage the systems feel that it is their responsibility to accommodate and encourage increase. Therefore, a limiting statement of capacity to deliver is seen as a reflection on their incapacity to perform their job properly. This is unfortunate, since it makes the assignment of social costs doubly

difficult. Also, there are many contingencies, many alternatives of the "if we add another pipeline here---or another teacher there" that make the facts of allocation of social costs very difficult to procure.

A curious American passion for statistics often finds expression in the operations of government as well as baseball. The burden of information procurement required by this simple ESPS may well be greater than most small enterprises are capable of providing. It is felt strongly that the demand of this system has already been reduced to a minimum. Effective implementation will require some assistance from state and federal agencies as well as private research organizations.

Few of today's small enterprises, even if they have a strong sense of environmental responsibility, know what to do. It is likely that few of them feel that they can afford comprehensive, detailed studies. Even fewer, we suppose, desire to be obliged to carefully attempt a prediction of their impacts. The ESPS, nevertheless, does make an important start in demonstrating to the public a feasible and effective means. In the process of completing an evaluation, at least some of the important questions are asked.

Without trying to ask vital environmental questions, without attempting to get some of the answers, there may be no way to prevent a gradual decline in the qualities of our habitat. A slow drift in which we perceive the end but are too paralysed to act, is the essential ingredient of tragedy.

Alternative approaches to the problem

In the course of our efforts to design an environmental site permit system, we have sought to consider possible alternate methods of regulating development of Montana's space. It was generally felt that development of the traditional sort, in which siting decisions are based exclusively, or nearly so, upon economic considerations, has resulted in severe degradation. Perpetuation of "do nothing" was not seriously considered as an alternative method. The "multiple use" concept, while perhaps applicable over a broad regional area, descends to economic conflict over use of immediate and particular local sites. This too was not thought to be a practical regulatory concept for our purposes.

Zoning

Zoning at various scales is the most widely accepted device now in use and constitutes a workable means of regulating development. In theory, zoning could be adapted to serve almost any objective. On a regional or "ecosystem" scale it could be applied so as to accord a high degree of protection to environmental quality. Historically, of course, zoning has served much more limited ends--principally a spatial segregation of types and levels of human life and activity--some of which have contributed to environmental and social disfunction. For example, at the local level, traditional zoning produces functionally and socially segregated neighborhoods which in turn generate large amounts of traffic with corresponding public expenditures to accommodate

the automobile. The hidden costs attributed to the lack of social intercourse in such situations, accompanied by the loss of large amounts of land to urban sprawl, are manifested in the unaccustomed economic burdens of repairing our dying urban central business districts.

Although workable in principle, an attempt to institute a statewide zoning system would meet with difficult problems. At the state level we find a lack of information which could conceivably back up wise land use decisions. The state does not yet have a detailed resource inventory, the minimum prerequisite for a comprehensive statewide zoning scheme which could even give lip-service to preservation of environmental quality.

We clearly see the eventual utility of a statewide resource inventory upon which decisions and relative judgments about enterprise and environment might be based. But we find that the cost and the time required to complete an adequate survey presents serious difficulties. We estimate that upwards of 10 years would be required to obtain legislative authorization, perfect a survey design, conduct a survey and then analyze the survey for zoning purposes. On the basis of estimates made for a Colorado study, the cost of a good resource inventory in Montana would be at least one million dollars. Even at that price, the scale of the survey would still be rather "coarse". The smallest area analyzed would contain 1000 acres or about 1.5 square miles. Resolution suitable for detailed site planning should segregate to about 5 acre sized parcels.

Alternative evaluation systems

These techniques are of two general types. One is basically subjective in that some relatively specific values are enunciated. The site location system of the state of Maine is of this type, as would be an on-site ad hoc evaluation by either experts or amateurs. Under Maine's system, applicants complete rather compendious questionnaires to be evaluated by the Environmental Improvement Commission without reference to quantified values. The alternative to such a subjective system is an objective system in which apparently relevant variables are given index values. Any objective system seems to boil down to the construction of such indexes. Different combinations of index values are then assigned meanings, possibly by resort to computer analysis of nationally equivalent data and experience, in terms of which, siting choices may be judged to be good or bad.

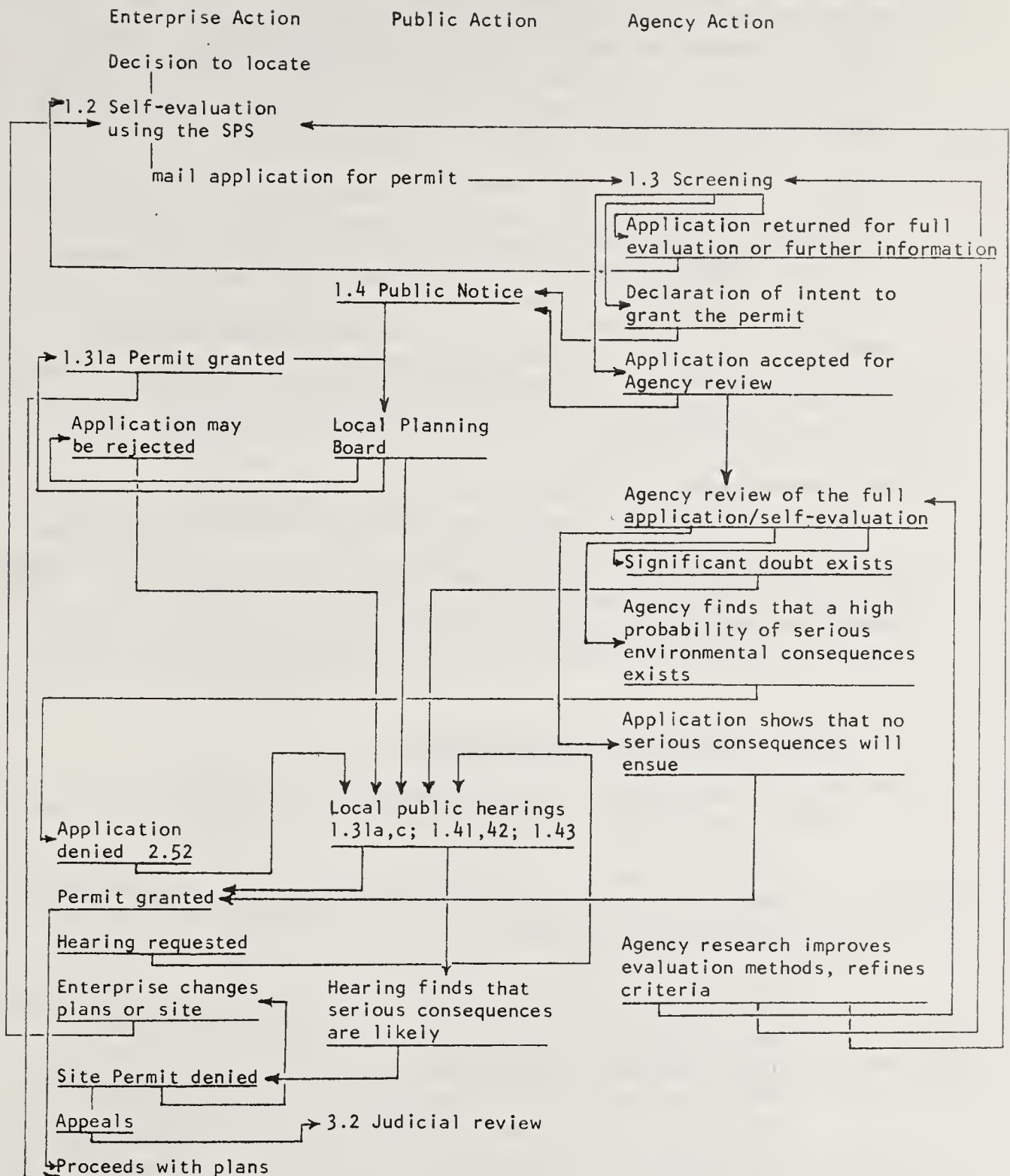
It seems clear that objective values must be implicit in Maine's system. Given enough experience, these values could be inferred from a record of site location permit decisions. We have attempted to design a system which is objective from the outset, capable of further objectivization, yet is sensitive to complex desires: emotion, beauty, and sense of fitness.

A variety of devices for independently indexing site and enterprise and for relating index values have been examined. For example, we considered Luna Leopold's scheme (Natural History, Vol. 78, October 1969) for comparing and scaling "uniqueness" of river valleys. We have looked at systems of two and three coordinates and have experimented

with logarithmic scales and geometric progressions as well as linear scales. We recommend that agencies or other large institutions also make use of "Geological Survey Circular 645, A Procedure for Evaluating Environmental Impact." The matrix is useful, but the rating scheme seemed too undirected to be useful at the scale of an individual site for a small enterprise. It is especially good in that particular kinds of environmentally modifying activities are identified and rated. Unfortunately, principles are not.

ENVIRONMENTAL SITE PERMIT SYSTEM

ADMINISTRATIVE FLOWCHART



Environmental Site Permit System

1.0--Scale of operation

An Environmental Site Permit System should be operated at the state or regional (Interstate) level of government. Local planning boards, whether county or municipal, simply do not normally have the necessary freedom of opinion or independence of influence to effectively restrain development that might be environmentally harmful over the long run.

The system should be made the major responsibility of an agency (or major department of an agency) responsible for regulation and research in the environmental sciences, pollution control, or public health planning. The system simply could not operate as an effective check process if it were within an agency responsible for promotion of economic development or economic planning. Branches of government devoted to information gathering, education, or service to particular sectors of the public would also not be likely to have the personnel, structure or spirit necessary to the task.

The independence of judgment that the system requires makes it necessary to guarantee some long term continuity of policy and finance. Although the system is designed to be openly responsive to public concerns, some shelter from the winds of personal political ambition, or economic conflict is necessary, if the people who make the evaluations are to have a base of security from which honest, courageous, and independent decisions can be made.

1.1--Administrative Responsibility

The agency charged with administering a system of Environmental Site Permits must:

- a. seek to preserve ecosystem integrity as a foundation for human health and the successful functioning of social and economic systems;
- b. maintain a process to evaluate and regulate the allocation of space in recognition of the dynamic interacting relationships between environmental processes, human needs and perceptions; (In such regulatory evaluations, the agency and its hearing boards must make their decisions in conformity with principles of sound land and resource use such as are expressed in arguments presented in the sections of this report that deal with land, air, water and social costs evaluations.)
- c. consider the consequences of proposed development and land use changes in relationship to the surrounding physical, social and economic contexts, making decisions, when necessary, on a basis other than monetary values, so as to secure the preservation of aesthetic character, historic identity, and long term resource-use alternatives of the land;

- d. attempt to predict and make known the environmental consequences of proposed developments in relationship to the locations chosen by public or private enterprise;
- e. develop, improve, and implement systematic methods of evaluation capable of detecting or predicting those ecologic relationships which extend the consequences of development to a wider or more general environmental degradation;
- f. make public such findings and information as may flow from the operation of the system and the research intended to improve the process; and
- g. maintain as open public records, all applications, attachments and evaluation reports.

1.2--Applicant entry

Any enterprise intending to alter, permanently use or modify Montana space must evaluate itself, using the ESPS format, procedure, and index scores. Together with the information required by the method of evaluation, the reported scores constitute an application for a site permit when received by the administering agency.

Any enterprise, whether or not a previous holder of a site permit, intending to expand, alter process, or otherwise re-organize the physical use of their site, must apply again for an ESPS review of an evaluation of the new conditions.

The granting of a permit on the grounds of an evaluation submitted for review by ESPS constitutes an explicit agreement to abide by the plans evaluated for the stated lifetime of the enterprise or consent to be required to re-apply prior to institution of any changes.

- 1.21--Commentary: Responsibility for initiation of application and the accuracy of information required, lies on the enterpriser, whether a public or private agency, institution or person.

In order to obtain the full benefit of public feedback, aspects of the system and the awareness produced by the evaluation process, the entry to the ESPS should be as broad as possible.

- 1.22--Since it is likely that the ESPS will at first be viewed as yet another governmental interference and obstruction, the information demands must be carefully balanced against the potential compliance costs, or the potential spirit of resistance to the concept of environmental protection. Control over the questions of ESPS applicability is probably a matter of political judgment

to be settled in the legislature, rather than by the granting of broad rule-making power to the administering agency. Some flexibility or discretionary power in the agency to alter the detail of evaluation may relieve the burden of compliance.

1.23--It is probably more in keeping with the spirit of the purpose of the ESPS and citizen participation to initially insist on a broad range of applicability such as is suggested in 1.2. Failing that comprehensive an entry, the following phrases are suggested: The full evaluation program need not be completed unless the enterprise contemplates:

- a. a functional change in land use of the site;
- b. the sealing, by paving or construction or covering of over 3,300 square feet (300 m²) of land area;
- c. the disturbance of the soil profile of over 2 acres (1.2 Ha) of land (except for agricultural cultivation purposes);
- d. the processing or use of over 2000 U.S. gallons (7,570 liters) of water per day;
- e. use or installation of the capacity to use the equivalent of 54 Hp or 40 Kw;
- f. the installation of combustion processes other than space or home water heating using natural gas, liquified petroleum gases or electricity;
- g. a possibility that operations may release toxic substances into the air, water, groundwater, or land surfaces;
- h. the direct or indirect removal of, or substantial change to the character of vegetation, associated faunal populations, or aesthetic attributes of the region immediately surrounding the site to be developed.

1.24--Consideration should be given to the construction of a [computerized] screening program matrix which could eventually segregate situations demanding progressively more thorough evaluations from those likely to cause no substantive change. This could only be done from a base of information and experience in the operation of the presently proposed system.

1.3--Screening of the application

When the application arrives, an initial screening for consistency and completeness of evaluation should follow an

overall scanning of the evidence relating to the items (a. through h.) under 1.23.

- a. examine the Geogram in contrast to the descriptive statement of the proposed enterprise; (Also note the land use incompatibility score at 9.254.)
- b. check the entry at Total disturbance score 9.334 land;
- c. make a subjective judgment on the basis of description of operation and the number at 9.334 land;
- d. compare statement and operation with the Hydrologic evaluation depletion potential index;
- e. subjectively compare knowledge about processes and the aerometric evaluation;
- f. make a subjective "probability of truth" estimate.

1.31--Initial disposition of application

After screening, the application may be handled in four different ways:

- a. If the application demonstrates that no real additional environmental danger is likely to ensue from the construction, completion and operation of the development, the enterprise, planning boards, city or county governments, and public health officials are notified of the intent to grant a site permit. Official notice of such intent is also to be published in two currently available local media on three consecutive odd numbered days. If no protests are heard, the permit is issued within ten days of first publication or twenty days from the date of the receipt of the application. (See 1.41)
- b. When the application is judged to be insufficiently precise or inadequate in information, it may be returned to the originator. If there are grounds to believe that the enterprise has falsified information on the application, he should be warned of the sanctions provided (1st. instance misdemeanor). If the second application is proven false in any important respect, it may be rejected and sanctions applied. Any third application must be in the form of sworn testimony or affidavit, falsification of which would

be a serious offense. The agency simply cannot engage its efforts in the evaluation of applications submitted in bad faith. Neither can it afford to engage in lengthy suits over matters of falsified information.

- c. When the application appears to be complete and worthy of serious study because either the enterprise is a potential danger to environmental conditions, or the site may prove to be easily damaged, the agency must indicate that it has been accepted for review. At this point the enterprise, local authorities, and the public should be notified. (See 1.42) If, in the opinion of the agency staff or director, the application is of such a magnitude and importance as to arouse serious questions in the public mind concerning local and environmental values, the agency may call a local hearing before a qualified board. If there has been significant and pertinent response to the public notification requirement (1.42a.), the agency must order a hearing to be held in the county seat nearest the intended site. In either case, the hearings must be called for prior to twenty days from the receipt of the application. Hearings must be held within the following 30 days.

1.4--Public Notification

In addition to prompt notification of appropriate local planning agencies or boards, two kinds of public notification are required.

- 1.41--In the case of an application deemed on first screening to be relatively insignificant in impact and environmental consequences, a notification of intent to grant a permit must be made public in two appropriate media available and currently in use by the neighborhood residents of the site locality. [One should be the traditional newspaper of general circulation, the other could be radio or television. Ideally, the notice should be part of an evening newscast and meet the requirements for the portion of time devoted to public service.]
- 1.42--If the enterprise is significant to the extent that a full review is required, or if full evaluation results from criticism from the locality, or if the proposed site is probably in danger from the proposed enterprise, or if, in the judgment of the agency director, the external aspects of the proposed development merit public treatment and involvement, the agency shall:
 - a. Make public a detailed description of the proposed enterprise which includes the location of the site; the identity of the applicant and the identity of ownership of the enterprise; information sufficient

to identify the scale of the proposed enterprise including the information relating to land disturbance, process identity, estimated fuel and raw material and product process weights; number of employees and estimated life-span of the enterprise. The information shall be published in two separate media available and in current use at the locality and county seat appropriate to the proposed site. The publication shall be made on five consecutive even-numbered days. Public commentary, including protest, criticism or approval, to be submitted within 15 days of the first notice, shall be solicited in the announcement.

1.43--The same general notification standards apply in contested cases, or hearings.

1.5--Local Planning Boards

Any properly qualified and empowered local planning board or agency shall have the right, within established due process, to deny or request that a permit be denied, but should not be able to grant a site permit over the objections of the ESPS agency.

2.0--Evaluation

The agency charged with administration of the ESPS should use, but not be limited to, the evaluation methods proposed in the Land, Air, Water, and Social Cost sections of this report.

2.1--Open Process

A professional agency staff (qualifications set forth in 4.12, 4.13) should evaluate applications and be prepared to make their findings public upon request. The process must be conducted openly in a spirit of cooperative scientific effort to discover and interpret the facts. Personnel must feel and be free to solicit, develop, and use information from all sources. It should be expected that such independent judgment will occasionally result in political tensions, unpopular truth, and even scientific error. It is important for all parties to a review to realize that prediction of the results of the operation or alteration of our complex, intertwined social and biologic systems is imprecise. Decisions may be impossible; recommendations will be difficult to make at times, and will probably be honestly vague.

2.2--Timeliness

The process of evaluation review should be timely and as efficient as possible. The agency staff must furnish the applying enterprise (and the public on demand) a report detailing the recommendations for disposition of the application. Such a report is to be available to the enterprise no later

than thirty days after agency receipt of the application, except for those cases in which the proper evaluation process demands expert professional opinion not available in the agency, public hearings must be scheduled, or enterprise caused delay has forced postponement. Refusal on the part of enterprise to promptly respond to reasonable agency requests for access to site, plans, or interview, will relieve the agency of its obligation to respond within the thirty day period.

2.3--Methodology of Evaluation

All applications must be evaluated or reviewed in the light of fair, consistent standards. The application must be checked for accuracy. Evidence of internal consistency and appropriate verification by comparison with known industrial standards or other physical parameters may be useful. In cases of substantial doubt, further supplementary evaluation may be developed through interview, site visitation, locality survey or other acceptable methodology.

The agency should develop, for internal use, routine tests of comparability suitable to the evaluation methodology, scale of proposed enterprise, and quality or character of the proposed site. Evaluation must not be limited to simply quantified concepts of economic feasibility. The agency should not commit itself to a single kind of evaluation methodology. Neither should it limit its concerns to single aspects of environmental quality. The approach should be trans-disciplinary and scientific in method.

2.4--Development of methodology

Much can be learned from experience. Operation of a site permit system is no exception. The agency personnel should be constantly engaged in a refinement of the methods to be used by the enterprise public in self-evaluation. The ESPS agency must also work to refine and develop the process by which the internal evaluations are made. It is suggested that research should be directed to: reducing the information load on the public; increasing the efficiency of the screening and evaluation; reduction of agency personnel through establishing the evaluation process as automatic and unsupervised. In both research and evaluation the agency must remain sensitive and open to the possibilities (and dangers) of technical changes which could alter the framework of prior principles of wise land use. The agency staff must be engaged in a continuous re-evaluation of the system used to rank the reviews of the application-evaluations submitted by the enterprise public. The ESPS system must be kept open to change.

2.5--Recommendations

Decisions will vary with the context of proposed developments in spite of the systematic evaluation process scores. As experience is gained, further refinement of the decision points in relation to scores will be possible. In the first, tentative operations of the ESPS it is suggested that:

2.51--Permits be granted routinely only if there is no more than a 40 percent score on any single section, with the total score below 30 percent of the possible.

2.52--That the application for a permit be rejected if the agency review concludes that the enterprise evaluation does not demonstrate that environmental damage will be minimal, or, if the score in any section is over 60 percent of the possible or if the total score is over 50 percent of the possible.

2.53--No matter what recommendations are made to the public and the enterprise, the agency staff must be firmly conscious of the process value of the system. The indirect effects of the self-evaluation mechanism, including the feedback provided through public participation, could prove over time to be as important a regulating mechanism as the rejection or granting of permits.

2.6--Rejection

When an enterprise is notified that its application for a permit has been rejected, a report of the agency review or evaluation giving the substantial reasons must be provided.

The agency must stop short of recommending alternate site choices, for the possibilities of involvement in such transactions are easily abused. But the agency should, insofar as is practicable, informally advise the enterprise of the critical shortcomings in his proposals. The agency must not get engaged in the business of performing the self-evaluations. Neither can it become a source of engineering design alternatives or be engaged in promotion of development.

3.0--Administrative Procedure

The ESPS administrative procedure should be subject to the Administrative Procedure Act. (1971, Revised Codes of Montana 1947 82-4201 through 82-4225)

In the drafting of an act to implement the ESPS, careful attention to the soundness of format for the public hearing and judicial review elements of procedure will be vital to success.

3.1--Hearings

Requests for hearings may be made by aggrieved parties, normally an enterprise whose application for a permit has been rejected.

The public may also, through the agency director, upon submission of relevant evidence or protest, request a hearing. The agency director may have discretionary power to call an administrative hearing. All hearings must be called and held promptly, within thirty days of the notice. The notice must include a statement of the time, place, and nature of the hearing, a statement of the legal authority under which the hearing is to be held, a statement of the statutory authority involved, and a short, plain statement of the matters asserted. Enough time must be afforded to all interested parties to respond and present evidence. Standing cannot be limited to those capable of showing an economic interest in the outcome, since land use decisions have broad effects beyond the ordinary bounds of property. Standing should be accorded to persons, not for the protection of their private interest, but to vindicate or define the public interest. Records must be kept during the hearing, and must include all pleadings, motions, and intermediate rulings, evidence presented, questions, offers of proof, objections and rulings thereon, and all findings and opinions of the hearing officer.

The hearing may be conducted before a board rather than a single officer, but the number of members should be limited to no more than five and all should be qualified in some aspect of environmental science, or land-use evaluation, and/or planning. A hearing board might well include the principal staff evaluator of the issue at hand. The local county or municipal Planning Board director might well be made a member of the board. During the hearing, statutory and common law rules of evidence shall prevail. Parties to the hearing, as in a trial, shall have the right to conduct cross-examination. Hearing officers should be authorized to administer oaths and--of great importance--issue subpoenas. The hearing board's recommendation must be in writing and contain a clear statement of findings of fact and statement of law supporting the recommendations. All interested parties must be notified, either personally or by mail of the final decision.

3.2--Judicial Review

A provision for judicial review of the agency decisions should be included. To insure that the minimum requirements are met in the drafting of an Act, the Administrative Procedure Act must be referred to. The most important element of this part of an enabling act is the statement that the court is limited to the record, in order to prevent enterprise from attempting to subvert the administrative system by holding out at the hearing level with an attempt to garnish a de novo trial.

In general, any act written to implement a site permit system must assure representation of local and public interest with fair procedure and abundant opportunity for the gathering and weighing of evidence.

4.0--Personnel

On the basis of some rather crude estimates of the potential case load it appears likely that staff evaluators would probably screen 1500 to 2000 applications per year. Of these it is thought that no more than 500 might warrant the full detailed review or re-evaluation.

4.1--Minimum estimated staff needed

A minimum skeleton staff should include the following:

4.12--Director

This person should be qualified by education, experience and personal commitment to environmental preservation. The position would require considerable political sensibility, and at least a Bachelor's degree in a broad based education that includes Biological Sciences but could also be in Sociology, Geography, Geology, Economics, or Anthropology.

4.13--Professional Staff

Although the system is designed to be relatively expert-free, professional judgment and awareness are required to properly assess or review the applications. A staff should have a broad representation of disciplines, including both social and natural sciences. A suggested assortment follows, the minimum requirement would be a Bachelor's degree in the field.

- a. Biologist, Environmental Ecologist, or Biogeographer;
- b. Urban Planner, Sociologist specialized in "Human Ecology", Urban Geographer or Economist;
- c. Agronomist, Rural Sociologist, Resource "manager";
- d. Recreational Resource "Manager", Wildlife Biologist, recreational planner;
- e. Economic Geologist, Geographer, Forester.

4.2--Additional staffing

Depending on the case load, a number of research assistants, perhaps many of them part-time students, graduate students, or working interns could be added.

Joint appointments should also be sought with other agencies in order to obtain access to expertise in computer programming, legal counsel, and systems analysis.

The agency should also have a literate editorial assistant to help prepare reports, notices, and persuasive public communications.

LAND

"What we need more perhaps is an ethic and aesthetic under which man practicing the qualities of prudence and moderation, may indeed pass on to posterity a good Earth."

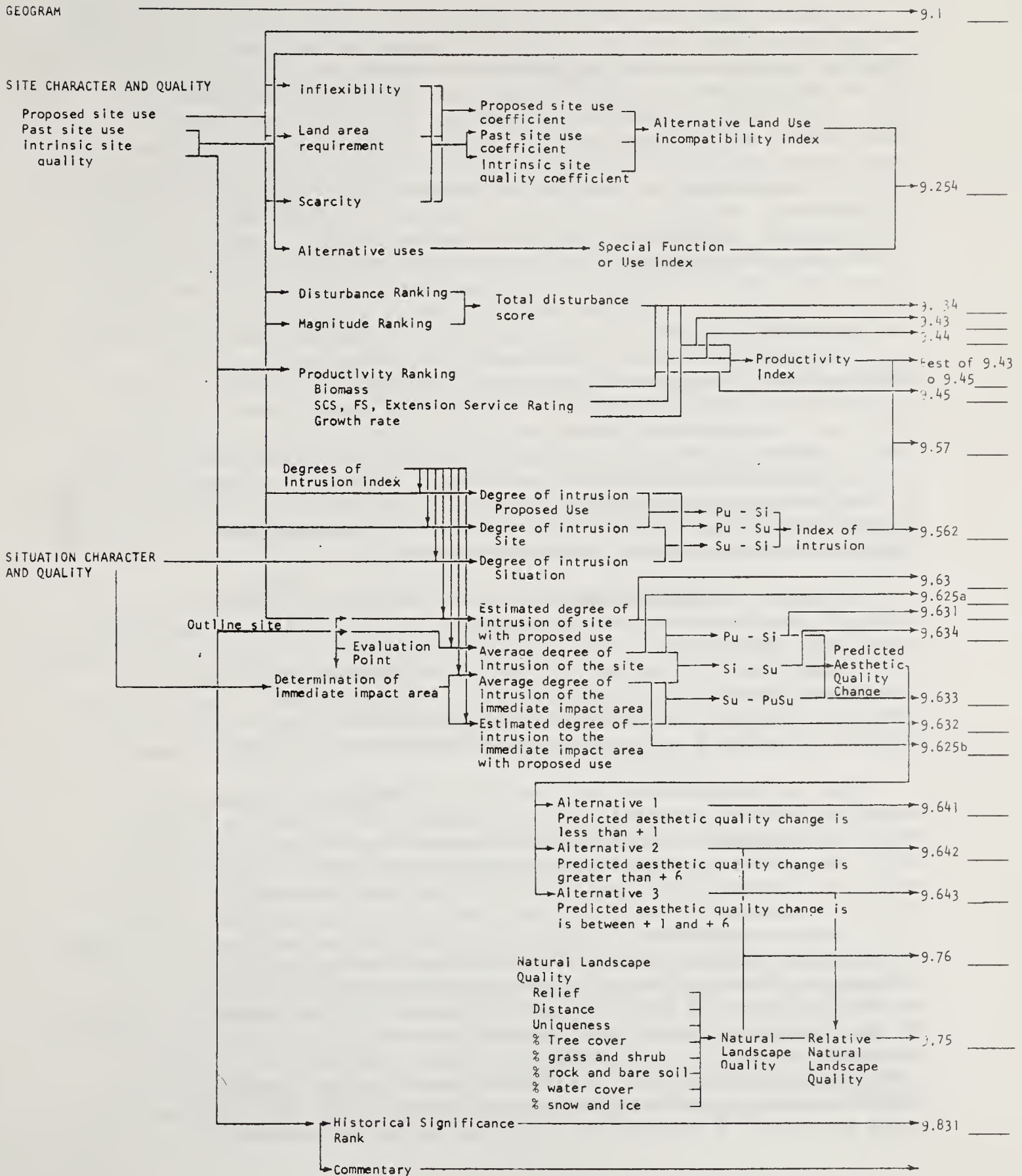
Carl O. Sauer 1956

"The commandment
 'Love thy neighbor'
must embrace all living things---"

Herman Mattern

LAND FLOWCHART

GEOGRAM



Whether seen as an object of love, the stage for a life and work, or just as another artifact along with labor and capital in the crude economic image, the word land evokes an emotional response. Most of us are able to recognize the reality of our ultimate dependence on land. The living biological web and the historical and spatial complexities of our uses of land operate together to produce what we know as the uniqueness of place. In this dynamic world the complexities of our relationships to land may make detailed mathematical modeling or reasonably complete inventories impossible or useless. The simplifications and categories of this evaluation series is not an attempt to estimate the importances of changes to land which could indirectly affect our physical, emotional, and environmental health. The basic concern is for the continued integrity of the long-term functioning of the landscapes we live in, use, and change. The outlook of the system is future-oriented, mostly concerned with minimizing practices destructive of fragile and biologically productive areas. The intent is to deflect developments towards locations appropriate to their potential environmental hazard so that in the long term, society will have a greater diversity of resource use options. Individual portions of this section may seem to be designed to perpetuate a status quo ante in environmental development, because they concentrate on indexing change. This fear is illusory. There is no system capable of stopping change, let alone predict its every turn.

Montanans should, however, be aware of the fact that they have a national responsibility for preservation of some of the few pristine lands left in the world. The continued existence of the "Big Sky Country" is of importance to the rest of the nation, since Montana bears an historical legacy uniquely preserved in its landscapes. Some of them must be saved, but it is equally obvious that the state will not and should not become a cultural museum or remain a "colonial" economy.

The land evaluations are a series of indexes and information gathering devices arranged so as to cumulatively provide a total score that represents the potential damage a particular development might cause to a specific site and its surroundings. They are: 1-1.2, an informational site identification and inventory; 2.0-2.54, a land use incompatibility index that ranks proposed land use change; 3.0, a simple magnitude of disturbance score to be used with the degrees of intrusion ranking; 4.0, a biologic productivity ranking; 5.0, a degrees of intrusion ranking which compares the proposed use with the present condition of the site and situation; 6.0, an aesthetic evaluation of the site and proposed use which may be combined with the natural landscape evaluation if the change is great enough; 7.0, a natural landscape evaluation; 8.0, a series of comments and guidelines which suggest an evaluation of historic significance; and 9.0, a method for score totaling. A discussion of nuclear plant siting is at 10.

Application for an Environmental Site Permit

1.0 General Information

All applicants must supply the following basic information even if a full self-evaluation is found not to be necessary.

- 1.10 Name of evaluator, address, telephone number.
- 1.11 Name of the enterprise, address, telephone number (home office).
- 1.12 Name of the enterprise owner, address, telephone (if different than above).
- 1.13 Legal description of the location of the proposed site.
- 1.14 General description of the site, indicating which portions it is intended to disturb or change.
- 1.15 General description of the proposed enterprise. The description shall include as appropriate the numbers of units involved, the weights, volumes and nature of raw materials to be processed; the numbers, kinds, and weights of finished products; the numbers of full- and part-time employees, the quantity, source and identity of the energy supply to be used, the estimated lifespan of the activity.
- 1.2 General description of the benefits to flow from the proposed enterprise.
- 1.3 A general discussion of the alternative means or locations that have been considered.
- 1.5 Site information

The following are instructions for making the initial site information summary on the "Geogram" (1.6).

1.51 Geogram code sheets

The Geogram is intended for use anywhere in the world, therefore many of the potential 640 entries do not have corresponding entries on the attached list. The "Code Sheets" in the following pages will be revised from time to time as information accumulates and greater precision of description becomes possible. The evaluator should make sure that he has the most recent version of the "Geogram Code Sheets."

The Geogram is divided into broad categories suitable for check list descriptions of the physical characteristics of a site. Some obvious cultural features are also included.

1.52 Classification

The principal major groupings are:

- Potential Natural Vegetation
- Unvegetated Land, Natural
- Cultivated Vegetation
- Micro-Habitats
- Air Space Quality
- Location Description
- Series of Mixed Patterns
- Series of Cultural Features
- Impounded Waters, Fresh Waters, and Saline Waters
- Shore and Island Features

The major problem with the above listing is, of course, the matter of choosing a description appropriate to the scale of the site being reported on. The major headings written on the Geogram provide a guide to the series of numbers on the code sheets where the specific descriptions may be found. If an appropriate description does not exist on the code sheet, choose a number in the proper section of the classification and write your own description on the back of the Geogram form. This information will be used to improve the precision of the system.

1.53 Site reporting

To begin, the evaluator should examine his site, preferably on foot, to know its character and condition. Then, by looking through the Geogram Code Sheets he should find numbered descriptions of those features present on the site. Each feature has a corresponding numbered box on the Geogram.

Once the numbered box for a feature is known, write in it the number that corresponds to its present condition (Excellent-1, Good-2, Fair-3, Poor-4, Bad-5). Entry of this number will serve to indicate the presence of the feature even if it is not important.

The next step is to choose a color or pencil pattern, fill in the Dominant box for a key, and then indicate by coloring or filling in the boxes of those features which dominate the site. Finally, choose another, lighter color

or pattern to fill in the subdominant box and those numbered squares appropriate to the second most important features.

It should then be possible, with a little experience, to read the Geogram and quickly know whether it was a forest, grassland, urban, poor, or productive site.

The name and format of the Geogram was designed by Max Nicholson of "Land Use Consultants", 139 Sloane Street, London, SW 1. The method is described in The Geographical Magazine, XLIV, No. 2, November, 1971.

1.7 --Sample Geogram

DOMINANT



PRESENT CONDITION



SUBDOMINANT



[Excellent-1, Good-2, Fair-3, Poor-4, Bad-5.]

1	2	3	4	5	6	7	8	9	10	321	322	323	324	325	326	327	328	329	330
	AIR SPACE									LOCATION INFORMATION									
11	CLOSED FOREST									331	TREE COVER								
21					26					341	BUSH CROPS								
31	CLOSED SCRUB									351									
41							48			361	FIELD CROPS								
51	OPEN FOREST							59		371	GRASSLAND				376	TREES AND			
61	SCRUB WITH TREES								70	381	ORCHARDS				386				
71	OPEN SCRUB									391	GARDENS AND HEDGEROWS								
81										401	AQUACULTURE								
91		93	TREE SAVANNA							411	DISTRIBUTION PATTERNS				416	BUILDINGS			
101									110	421	MIXED								
111	SHRUB SAVANNA								120	431									
121	GRASS AND HERBS									441					446				
131										451					456	STRUCTURES			
141							147			461					466	MOBILE EQUIPMENT			
151	AQUATICS-LAND									471					476	FILLED LANDS			
161				165						481					486	LEVELED SURFACES			
171	OPEN STEPPE AND FOREST SCRUB									491					496	EXCAVATIONS			
181										501					506	UNDERGROUND			
191							197			511					516	DERELICT AREAS			
201	STEPPE SAVANNA								210	521					526	RUINS			
211	STEPPE						217	LICHEN		220	531					536	ISOLATED		
221	AQUATICS						227				541	MICRO-ARTIFACTS				546	DEFENSE AREAS		
231	DESERT GRASS						237	DESERT SCRUB			551					556	IMPOUNDED WATERS		
241					246				250	561	NATURAL MICRO-HABITATS				566				
251										571					576				
261										581	FRESH WATERS								
271	UNVEGETATED REGOLITH SURFACES									591									
281								289		601					606				
291										611	SALINE WATERS						618		
301	SNOW AND ICE									621	ISLANDS				626	SHORES			
311										631									

The following numbered descriptions correspond to boxes on the Geogram (1.6)

1-10 Air Space

- 1 Open plains, plateau top, etc.
- 2 Open hilly (local relief less than 1000' (300 miles)
- 3 Open mountainous (local relief over 1000' (300 miles)
- 4 Long open valley mountainous (1000')
- 5 Closed mountain valleys (under 5 miles (8 km.) across)
- 6 Stagnant, frequent inversions, fog
- 7 Windy conditions prevail
- 8 Urban conditions
- 9
- 10 Classic "Big Sky Country"

Potential Natural Vegetation

11-25 Closed Forest

- 11 Douglas fir forest (Kuchler 12)
- 12 Cedar - Hemlock - Pine (Kuchler 13)
- 13 Grand fir - Douglas fir (Kuchler 14)
- 14 Western spruce - fir (Kuchler 15)
- 15
- 16
- 17
- 18
- 19
- 20
- 21
- 22
- 23
- 24
- 25

26-47 Closed Scrub

- 26
- 27
- 28
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- 35
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- 37
- 38

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48-58 Open Forest

48 Western Ponderosa Forest (Kuchler 11)
49
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51
52
53
54
55
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57
58

59-69 Scrub with Trees

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60
61
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69

70-80 Open Scrub

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93-109 Tree Savanna

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111-119 Shrub Savanna

111
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119

120-140 Grass and Herbs

120
121 Wheatgrass - needlegrass - medium to tall grassland (Kuchler 66)
122 Grama - needlegrass - wheatgrass - short to fairly dense
grassland (Kuchler 64)
123 Foothills Prairie (Agropyron-Festuca-Stipa) (Kuchler 63)
124
125
126
127
128
129
130
131 Alpine Meadows and Barren (Kuchler 52)
132
133
134
135
136
137
138

139

140

147-160 Aquatics-Land

147 Northern Floodplain Forest (Kuchler 98)

148 Cottonwood Floodplain, open

149

150

151

152

153 Seasonally flooded basin or flat

154 Open fresh water less than 10 feet deep

155 Shallow fresh water marshes: bulrushes, cattails, pickerelweed,
smartweed, rice cutgrass, carex156 Deep fresh marshes, 6 inches to 3 feet water in growing season:
waterweeds, milfoils, duckweeds, spatterdocks

157

158

159

160 Saline marshes: alkali bulrush, widgeongrass sagopondweed

165-196 Open Steppe and Forest Scrub

165

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197-209 Steppe Savanna

197

198

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206

207

208

209

211-216 Steppe

211 Sagebrush steppe (Kuchler 55) Artemisia - Agropyron

212

213

214

215

216

217-219 Lichen

217

218

219

221-226 Aquatics

221 Willow and Alder stream and meadow thickets

222

223

224

225

226

231-236 Desert Grass

231

232

233

234

235

236

237-240 Desert Scrub

237
238
239
240

246-249 Aquatics

246 Canal or ditch-bound phreatophytes
247 Impounded water marshes, game management areas
248
249

Unvegetated Land, Natural271-280 Unvegetated Regolith Surfaces

271 Fell Field - mountains, high elevations
272 Scree slopes
273 Stream gravels
274 Sands
275 Clays and silts - undissected
276 Badlands
277
278
279
280

301-310 Snow and Ice

301 Glacier
302 Snowfield persistent into August
303 Potential ski areas
304 Actual ski areas
305
306
307
308
309
310

321-330 Location Information

321 Floodplain, levee
322 Terrace, benchland
323 Basin floor, valley floor, not floodplain
324 Hillslope base
325 Hill or mountain slope middle or high
326 Ridgetop, hilltop, rimrock edge
327 Open high plain or broad rolling hill
328 Waterside

329 Coulee
330

35

Cultivated Vegetation

331-340 Tree Cover

331 Light open cover (5 to 30%) "tree farming forestry"
332 Open cover (30 to 60%) "tree farming forestry"
333 Closed cover (60 to 100%) "tree farming forestry"
334 Intercropped (i.e., pasture or hay under orchard trees)
335
336
337
338
339
340

341-350 Bush Crops

341 Irrigated
342 Non-irrigated
343 Clean tilled
344 Continuous cover
345
346
347
348
349
350

361-370 Field Crops

361 Dry farming, alternate year rotation - fallow
362 Irrigated continuous cover (hay and pasture)
363 Irrigated clean-till
364 Clean-till annual non-irrigated
365
366
367
368
369
370

371-375 Grassland

371 Improved range
372 Improved pasture
373 Improved pasture irrigated
374 Enclosed rotation pasture irrigated
375 Open range, unimproved

376-385 Trees and Orchards

- 376 Forestry - lumber
- 377 Forestry - pulp and paper
- 378 Forestry - special purpose (Christmas tree, nursery)
- 379 Fruits
- 380 Nuts
- 381 Shelter belts
- 382
- 383
- 384
- 385

386-400 Gardens and Hedgerows

- 386 Domestic suburban non-commercial
- 387 Commercial truck or market gardening
- 388 Rural parks - tended recreational vegetation
- 389 Urban-suburban parks - special feature, i.e., rose garden
- 390 Urban-suburban recreational - golf courses
- 391 Home orchards, non-commercial
- 392 Suburban nurseries
- 393
- 394
- 395
- 396
- 397
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- 399
- 400

401-410 Aquaculture

- 401 Trout farms, fish hatcheries
- 402 Waterfowl preserves
- 403
- 404
- 405
- 406
- 407
- 408
- 409
- 410

Mixed Types

411-415 Distribution Patterns

- 411 Classic Montana Ranch Landscape (Big Hole)
- 412
- 413
- 414
- 415

Cultural Feature

416-420, 426-430, 436-440 Buildings

416 Administrative - Community Service - Government
 417 Commercial - retail, wholesale, etc.
 418 Educational and cultural - schools, museums
 419 Industrial - factories, workshops, repair shops
 420 Residential - single
 426 Residential - multiple
 427 Residential - high rise, multiple
 428 Social-Recreational - movies, churches
 429 Historic places
 430
 436
 437
 438
 439
 440

Mixed Types

421-425, 431-435, 441-445, 451-455 Mixed

421 Suburban recreation "natural" - golf, riding and walking parks
 422 Suburban recreation "noisy" - Go-cart tracks, stock car or
 other racetracks, drive-ins
 423 Mechanized rural recreation, i.e., ski areas with lifts
 424 Undeveloped rural recreation, i.e., hunting, primitive
 425 Developed rural - Picnic grounds, campgrounds
 431
 432
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Cultural Features

456-460 Structures

456 Manufacturing processing special buildings
 457 Transport network - bridges, overpasses, etc.
 458 Dams

- 459 Power transmission facilities
- 460 Communications facilities

Mixed Types

461-465, 471-475 Mixed

- 461
- 462
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- 473
- 474
- 475

Cultural Features

466-470 Mobile Equipment

- 466 Auto sales, farm equipment, trailer sales
- 467 Residential trailer "courts"
- 468 Marinas
- 469
- 470

476-480 Filled Land

- 476 Sanitary waste disposal
- 477 Transport network
- 478 Dumps - tailings
- 479 Flood control
- 480

Mixed Types

481-485, 491-495, 501-505 Mixed

- 481 Montana Ranch - irrigated tree cluster farmstead
- 482 Plains town - irrigated trees, grain elevator, small houses
- 483
- 484
- 485
- 491 Feedlots, intensive dairying, stockyards
- 492 Purebred breeding operations (Herefords, Quarterhorses, etc.)
- 493 Small animals - chickens, minks, etc.
- 494 Dairying with pasture (low intensity)

495

501

502

503

504

505

Cultural Features

486-490 Levelled Surfaces

486 Levelled farmland, irrigated or not

487 Transport purposes - canals, highways, airports, etc.

488 Parking lots, playing fields, drive-ins

489 Sanitary solid waste landfill

490 Housing, other building purposes

496-500 Excavations

496 Canals, ditches, highways, other transport purposes

497 Construction of housing, commercial building, basements

498 Waste disposal, infiltration pits, settling ponds

499

500

506-510 Underground

506 Pipelines, fuel, power

507 Pipelines, water, sewage

508 Storage tanks

509

510 Mines - adits, shafts, wells

Mixed Types

511-515, 521-525, 531-535 Mixed

511 Open pit mines, strip mines

512 Strip or pit mined areas, reclaimed

513

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533
534

Cultural Features

516-520 Derelict Areas

516 Abandoned dredged gravels
517 Mine and smelter tailings including slag
518 Sterilized ground, accidents, waste, herbicide sprays
519 Non-revegetating slopes--(disturbance) can include range
and farmland as well as forested or mined land
520 Junkyards, open dumps

526-530 Ruins

526 Abandoned settlements - ghost towns
527 Abandoned single camps or dwellings, or farmsteads
528 Abandoned industrial property
529 Single historic features - church, school, battlegrounds
530

536-540 Isolated

536 Wilderness area
537 Lone farmsteads
538 Transmission stations - communication
539 Prospect pits, craters, dams
540

Micro-Habitats

541-545, 551-555 Microartifacts

541 Small buildings, tepee rings
542 Abandoned automobiles
543 Small ditches
544
545
551
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554
555

546-550 Defense Areas

546 Forts, military reserves
547 Missile silos
548 Communications facilities
549
550

556-560 Impounded Waters

556 Stock ponds
557 Minor irrigation dams
558 Minor flood and power dams
559 Major "multipurpose" dams
560 Controlled level lakes

Micro-Habitats

561-565, 571-575 Natural Micro-Habitats

561 Alpine fell field
562 Alpine larch communities
563 Small units of specifically identifiable: grassland
564 Small units of specifically identifiable: forest
565 Small units of specifically identifiable: shrub

571
572
573
574
575

Natural Waters - Fresh

581-605 Fresh Waters

581 Class A
582 Class B
583 Class C
584 Class D
585 Class E
586
587 Navigable (by 16 foot open canoe)
588 "Blue Ribbon" trout stream
589
590 Hot Springs
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Natural Water - Saline

606-617 Saline Waters

606 Hot springs
607 Wildlife, especially waterfowl habitat - marsh
608
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613
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615
616
617

621-625 Islands

621 Vegetated
622 Unvegetated
623 Seasonal isolation only
624 Uninhabited at any season
625

626-630 Shores

626 Rock
627 Shingle-gravel
628 Sand
629 Marshy (also deltas)
630

2.0 Land Use Incompatibility Index

From the point of view of environmental preservation, it is best if the most intensive human uses of land are confined to the smallest and most appropriate areas. This ideal can only be approached if the activities that are functionally the most consumptive of space and most dependent on the specific physical qualities of that space have priority in siting considerations. It should be obvious, for instance, that efficient agriculture or forestry depends on the use of land which is most inherently or potentially productive of food, fibre, or timber. The fact that regional differences in economic demand may alter the allocation of space or land qualities between the different agricultural uses should not obscure the fact that other uses such as housing or transport do not depend on the inherent productivity of the land. The building of cities and superhighways on good agricultural land is a foolish waste of fundamental natural resources.

Not only do agriculture and forestry require the most land space per unit of production, their physical requirements of the land are the most inflexible. Such uses are more land-specific than others. Flexibility in demand on the physical qualities of space must be made an important factor in siting decisions for the long term. In any decision bearing on land-use allocation, the relative factor of scarcity cannot be eliminated. Since society demands a variety of resources, including substitutes over time, the scarcities are relative in both the spatial and qualitative sense. Perception of scarcity/abundance normally is a substantial basis for any pricing scheme, but in regional or national markets environmental qualities have not been as systematically treated as, say, lumber. Scarcities of land qualities are perceived in the contexts of our changing knowledge of alternatives, options, and desires. Any scheme of evaluation based on dollar pricing would always be anachronistic. Nonetheless, resource scarcity should be included in an evaluation of site choice. Land intrinsically suited to irrigation farming is relatively scarce in Montana, but grazing space is more abundant. Although current market values may lead to the same general sort of space allocation suggested by the above three factors, the market place often seems short-sighted, failing to anticipate the longer-term needs of a society.

Economics has traditionally ignored biologic demands. Irrevocable changes to our environment, however economically feasible they may seem in the present, may destroy vital opportunities or force changes in biotic relationships that will either create costly scarcities or determine that the future will be without.

- 2.1 Land use incompatibility index scores are obtained by ranking land uses according to criteria of:
 (a) inflexibility; (b) land area requirements; and
 (c) scarcity. The result is a ranking of major land use coefficients for both past and present site uses (2.2) to compare land use alternatives.

In Table I, which follows, other uses than those listed may be interpolated and ranked. Enter the use in the box appropriate to criterion listed in the left-hand column. Each use accumulates the sum of the three box scores (figures in parentheses). This sum is fitted into the ranking of the major uses.

The following ranking was produced from Table I.

Forestry--100	
Irrigated Agriculture--95 (soil suitability and	
	water proximity)
Natural Recreation--95 (as compared with	
	Mechanized Recreation)
Dry Farming--80	
Grazing--75	
Mining--90 to 75	
Transportation--45	
Manufacturing and Processing--40	
Commercial Buildings--35	
Housing--25	

An example of interpolation, Mechanized Recreation, is underlined. The score is $5 + 30 + 30 = 65$.

TABLE I

Land Use Ranking Coefficients

Criteria	Rank			
	100 First	75 Second	50 Third	25 Fourth
Inflexibility or locational dependence on inherent qualities of the land	(50) Irrig. Agriculture Natural Recreation Mining Forestry	(35) <u>Mechanized Recreation</u> Dry Farming Grazing	(15) Transport, Commercial Bldg. Mfg. and Proc.	(5) Housing
Land area requirement	(35) Forestry Dry Farming Natural Recreation Grazing	(30) <u>Mechanized Recreation</u> <u>Irrig. Agriculture</u> Mining (coal)	(25) Transport	(15) Housing Comm. Bldg. Mfg. and Proc. Mining (metals)
Scarcity (Montana)	(15) Irrig. Agriculture	(15) Forestry Dry Farming	(10) Grazing Mfg. and Proc. Nat. Recr. Mining	(5) Comm. Bldg. Transport Housing <u>Mech. Recreation</u>

2.3 Index

Table II below is introduced for the purpose of comparing the proposed use of a specific site to either the past uses of a site or the intrinsic qualities of the land of that site. If, for example, the land has a history of irrigated farming it is presumed that it had some intrinsic qualities suitable to that purpose. Since most of the frontier is gone, even in Montana, most evaluators will have to judge prior use rather than make a quality judgment of the capacity for supporting agriculture, forestry, or dry farming. When the suitability of the site leads to great difficulty in perception of alternative uses, recourse to the opinions and methodology of the Soil Conservation Service can be considered authoritative. The Land capability classes of the SCS may also be used as evidence. The roman numerals following the left-hand column use rankings that indicate the range of SCS classification acceptable for that use.

If the proposed use (top row) is intended to be installed on land of a higher use rank (read across to the appropriate left-hand column) an index score can be read at the column row intersection. This index score represents the whole number between 1 and 10 nearest to the quotient obtained by dividing the assigned past use, inherent quality or SCS Capability Index assigned in Table I by the proposed uses index assigned in the same table.

2.4 Special functions, unique uses.

Imprecise as the above ranking is, there are numerous possibilities of misuse which could escape observation.

Although a site may be perceived and classified, for example, as a secondary forest (thought useful primarily for forestry uses), the entire value of that land might not be reflected by that label. Any forest could function in a number of different ways; not merely as a producer of trees. In similar ways, a range may have multiple functions. Such additional uses must be considered because they may significantly alter site values to local communities. Such situations are seldom encompassed by the land use classifications, and should include such diverse uses as undesignated or informal community picnic areas, old swimming holes, neighborhood fishing access points, relict stands of virgin timber, landmark trees, or unique and fragile portions of ecosystems such as alpine, or wet prairie and marsh.

The values of such places are high because the areas

could not be replaced or substituted at any reasonable cost by the local community or the state. The areas need not be "wild or natural" to be classed as special, although "natural" areas should not be excluded as a class simply because they are already protected under the other kinds of evaluations. There should be, however, a specific local reason to class such uses apart from the rankings given in the aesthetic and natural landscape evaluations.

TABLE III

Uniqueness

Depending on the available alternatives in the locality	
Watershed.....	5 to 10 points
Scientific base-line study area.....	6 to 10 points
Unique recreational opportunity.....	5 to 10 points
Wildlife:	
winter range.....	7 to 10 points
migration corridor.....	6 to 10 points
rare and endangered species habitat.....	5 to 10 points
Traditional Bitterroot gathering site, etc.....	4 to 7 points

2.5 Total score

2.51 Enter land use name and ranking from Table I (2.1).

2.52 Enter index from Table II (2.3).

2.53 Enter points from Table III (2.4).

2.54 Enter the product of entry 2.52 times the entry 2.53 _____. This is the final score for this section; enter at 9.254.

3.0 Simple Disturbance Score and Magnitude of Disturbance Index

3.1

TABLE IV

Disturbance Ranking

Area and kind of disturbance (square meters) or $\text{ft}^2 \times 0.093$	Class multiplier
1. area excavated, filled, or covered by buildings (note item 6 below)	_____ (5)
2. area paved or sealed to infiltration.....	_____ (4)
3. area graveled, laid bare, or maintained free of vegetative cover.....	_____ (4)
4. area of altered or degraded vegetation multiplied by the [percent of original plant cover minus the percent of newly established cover].....	_____ (2)
5. area devoted to enhanced biomass production (the good men do is oft interred in their statistics).....	_____ (0)
6. area to remain in its former condition <u>even</u> <u>if it is developed land</u> (in order to encourage the concentration of use on sites already lost).....	_____ (0)

3.2

TABLE V

Magnitude Ranking

If the disturbances on the site will be:	Take a factor of:
---	-------------------

1. under 100 m ² (1,076 ft ²).....	1
2. over 100 up to 500m ²	2
3. from 500m ² to 1000m ²	3
4. from 1000 to 4000 (an acre).....	4
5. 4000 to 6000m ²	5
6. 6000 to 10,000m ²	6
7. 10,000 to 50,000.....	7
8. 50,000 to 100,000m ²	8
9. over 100,000m ²	9

3.3 Disturbance score

The total disturbance score is obtained as follows:

- 3.31 Determine the subdivision of the site within the six categories of (3.11 to 3.16 from Table IV).
- 3.32 Find the appropriate magnitude factor for each class.
- 3.33 Multiply the factor times the multiplier for that class.
- 3.34 Add together the products (up to six) for a total disturbance score; enter at 9.334.

4.0 Biologic Productivity

It is environmentally and economically unwise to destroy our biologically most productive areas, be they range, swamp, forest, or farmland. Productivity of a particular site must be considered in relation to any estimated diminishment resulting from the destruction or alteration by the contemplated activity. In this evaluation a ranking of estimated productivity is multiplied against the magnitude of disturbance index score (3.34).

4.1 Measurement and ranking problems

In order to bypass the problems of measuring the specific amount of productivity on each of the disturbance levels at each site, an average factor must be devised. Time, rate, and local variations pose serious technical measurement problems apart from the artificiality of attempting to segregate a portion of a whole ecosystem. An estimated measure of productivity can be reflected in the biomass of a site (grams per square meter per year). This figure could be derived from: (a) expert field determination; (b) some rather inaccurate tables; (c) indirect measurement of energy flux, or litter depth, harvest, CO₂ assimilation, O₂ production, or Soil Conservation Service land capability classification, range condition classification and condition; (d) tree size and maturation period or proportion of bare ground showing. Additional remarks follow in section 4.7.

The range of productivity is very great in Montana, ranging from about 200 to 4000 gr./m²/yr. with forest production higher than that of grassland and many crops. Crop production has been excluded from consideration since one of the objectives of other portions of the land evaluation is the saving of agricultural lands from other developments.

4.2 Tentative ranking and multiplier factor

Rank and factor	Productivity per square meter per year as measured by representative random sampling methods
1	500 grams
2	500 to 1000 grams
3	1000 to 2500 grams
4	2500 to 4000 grams
5	greater than 4000 grams

- 4.3 Enter the product of the appropriate factor and the disturbance score (3.34) at 9.43.

4.4 Alternative productivity estimate method

Obtain a forest or range analysis by the Forest Service, County Extension Office or the Soil Conservation Service. In such analyses the plant community structure, condition and carrying capacity are adequately estimated. Expert opinion that compares the intended site with nearby locations in similar situations is acceptable. The rank factor for this estimate should also be multiplied by the disturbance score (3.34) to be entered at 9.44.

Rank and factor	SCS, FS, or Extension Service rating
2	poor
3	fair
4	good
5	excellent

4.5 Second alternative productivity rating

Tree growth rates may be good indicators of forested site productivity. Timber stands may be stunted by overcrowding, disease, or pest infestation, but that is not easily measured in a widely applicable fashion. The crude measurement of the diameter of the trees at breast height is considered in relation to the time required for the tree to reach that diameter. To make the table less complex, the diameters are stated in terms of 100 years of growth. A random sample of the trees in the development area should suffice as long as the aspect or slope is uniform. Otherwise, the site must be divided into units of uniform character, with each evaluated independently for its productivity per unit of space. The index of each unit's productivity is then multiplied by its percentage of the total site. These products are then added with the average productivity index resulting.

To determine the diameter of a tree 100 years old, one may measure the diameter of old stumps which have at least that many years of growth rings, or one can measure the diameter at 50 years and double for approximation. An increment bore should be used if no stumps are available.

Rank and factor	100 year diameter dbh.
1	6 inches
2	9 inches
3	12 inches
4	16 inches
5	over 16 inches

- 4.51 Enter the product of the tree growth factor and the disturbance score (3.34) at 9.45 only if 9.44 and 9.43 are impossible to use.

4.7 Future evaluation

Suggestions to be developed for future productivity evaluations of any site in Montana:

Listed below are the factors which should be evaluated in determining the productive potential of Montana land. Tables which have been developed and may be of use in evaluating the productive potential of Montana land are included. Comments and proposals relating to the lines of future research are offered.

4.71 Topographic factors

a. Slope

The slope of the land on the site is currently evaluated in the SCS Land Capability Classification according to the following standards:

0 to 2% slope	--	most desirable condition
2 to 5% slope	--	less desirable condition
5 to 9% slope	--	less desirable condition
9 to 18% slope	--	less desirable condition
18 to 35% slope	--	less desirable condition
35% slope	--	less desirable condition

b. Complexity of slopes

Each slope on a site should be evaluated individually.

c. Aspect

The aspect of the site should be evaluated as it affects the available solar energy.

d. Complexity of aspect

Each different aspect on the site should be evaluated individually.

4.72 Edaphic factors

a. Depth to parent material

The depth of the soil to parent material is currently evaluated in the SCS Land Capability Classification according to the following standards:

60"	-- most desirable condition
40" to 60"	-- less desirable condition
20" to 40"	-- less desirable condition
10" to 20"	-- less desirable condition
10"	-- less desirable condition

b. Permeability

The permeability of the soil to water is currently evaluated in the SCS Land Capability Classification according to the following standards:

6"/hr	-- less desirable condition
2"-6"/hr	-- less desirable condition
.6"-2"/hr	-- most desirable condition
.2"-.6"/hr	-- less desirable condition
.2"/hr	-- less desirable condition

c. Stoniness

The amount of stones of diameter greater than ten inches is evaluated in the SCS Land Capability Classification according to the following standards:

.01% of surface area covered	-- most desirable condition
.01%-.1%	-- less desirable condition
.1-3%	-- less desirable condition
3%-15%	-- less desirable condition
15%-90%	-- less desirable condition
90%	-- less desirable condition

d. Alkalinity-salinity

The alkalinity-salinity of the soil is evaluated in the

SCS Land Capability Classification. Information on the standards used to evaluate factors 4.72a through 4.72h is available from the SCS.

e. Texture

The texture of the soil is evaluated in the SCS Land Capability Classification.

f. Effects of past erosion

The effects of past erosion on the soil are evaluated in the SCS Land Capability Classification.

g. Water-holding capacity

The water-holding capacity of the soil is evaluated in the SCS Land Capability Classification.

h. Fertility

The fertility of the soil is evaluated in the SCS Land Capability Classification.

4.73 Climatic factors

a. Length of frost-free season

The length of the frost-free season is evaluated in the SCS Land Capability Classification according to the following standards:

120 days	-- most desirable condition
105 to 120 days	-- less desirable condition
90 to 105 days	-- less desirable condition
60 to 90 days	-- less desirable condition
60 days	-- less desirable condition

It must be emphasized that the length of the frost-free season, the mean annual precipitation and the precipitation effectiveness index have all been determined over wide climatic belts only. On particular sites these factors may vary widely. Future research should be directed toward developing methods of analysis in these areas for specific sites.

b. Mean annual precipitation

The mean annual precipitation is currently evaluated in the SCS Land Capability Classification according to the following standards:

18"/yr -- most desirable condition
 14"-18"/yr -- less desirable condition
 10"-14"/yr -- less desirable condition
 10"/yr -- less desirable condition

c. Precipitation effectiveness index

The precipitation effectiveness index is evaluated in the SCS Land Capability Classification according to the following standards:

>31 -- most desirable condition
 25-31 -- less desirable condition
 <25 -- less desirable condition

4.74 Solar energy available during the growing season

The amount of solar energy available during the growing season is not presently considered by any of the systems attempting to measure the productive potential of Montana land.

Presently, it would be extremely difficult to accurately measure the amount (in kcal/cm²) of solar energy available on a specific site during the growing season. Calculations can be made which will yield the theoretical total possible energy available at a given latitude during the growing season. Such a method is highly unsatisfactory on a site scale as it fails to consider interruptions in solar input caused by particles in the atmosphere or overcast conditions, or minor variations in aspect.

Research should be directed toward developing a method of measuring, estimating, or calculating the amount of solar energy actually available during the growing season on specific sites.

High energy flow sites not otherwise limited should be preserved for biotic production whether in direct economic human use or not.

4.75 Vegetative factors

In evaluating vegetative factors in relation to the potential productivity of the site, it is very important to be aware that both the type and amount of vegetation on the site may not relate nearly so much to the potential productivity of the site as they do to what is happening on that site, or what happened on that site in the recent

past. A site with a very high potential productivity might be extremely degraded, supporting low amounts and little variety of vegetation. Conversely, a site with a low productive potential might be supporting relatively greater amounts and variety of vegetation.

The vegetation on the site should be evaluated separately from the productivity potential of the site and should, somehow, comprise a separate section of the Site Permit System evaluation.

This evaluation would probably take the form of an evaluation of the condition of the vegetation on the site. Separate procedures of analysis and evaluation would have to be devised for each ecosystem type in Montana.

The leader in this type of work is the United States Forest Service. They have developed a comprehensive range analysis technique which is applicable over all of Montana. This technique is covered in FSH 2209.21 RH, Range Environmental Analysis Handbook. This explains the complete process by which the Forest Service classifies range condition as being excellent, good, fair, poor, or very poor.

Vegetative factors which are considered by the Forest Service in determining the vegetative condition of range sites are as follows:

1. composition (desirables, least desirables and intermediates)
 2. relative perennial plant density
 3. plant vigor
- 4.76 Other factors which might be used in future analyses of vegetative condition are as follows:
1. biomass
 2. diversity of species
 3. desirables/least desirables ratio
 4. leaf fall/litter ratio
 5. area of bare soil/area of vegetation ratio

The possibility of using any of these factors to evaluate vegetation condition seems very remote at present. Procedures of analysis and standards of evaluation would have to be developed for the various ecosystems in Montana.

5.0 Human Intrusion, the Cultural Landscape

Man changes something wherever he works or plays. We create the world we live in by transformation of the original, the natural. With values, desires, and techniques we construct cultural landscapes that reflect our social purposes and methods in the structure and organization of the land and its life.

As long as the dimensions of these landscapes remained within a localized human scale, understandable to most of its inhabitants as the product of simple tools worked within scales of efficiency appropriate to organisms, we could accept them as fitting within our concept of the natural. But, in the sense of being untouched by man, it is safe to say that there are no natural landscapes left in the world. The landscapes of the "good old days" were no more natural than are today's machine-plowed expanses of Eastern Montana. Population growth and technological development has made it necessary to accept such changes as inevitable if not natural. Many feel, however, that trends are such as to cause the loss of even these rural landscapes to rampant urban sprawl, mining, tourism, or government agricultural policies.

Discomfort with this conclusion should point up the fact that our society is beginning to be conscious of the qualities of the places in which we live. There is a concern for the maintenance of a diversity of what is now called "life styles." These people need suitable places if they are not to suffer on as incomplete shadow plays or misfit anachronisms. Landscape consciousness is constructed out of a knowledge of geographic content and awareness of historico-cultural continuity. The associations of place combine with occupational, historic, or ethnic identity to heighten sensibility to and appreciation for the value of whole, functioning landscapes for living. Another ingredient essential to landscape consciousness is awareness of ecologic relationships. It is in the appreciation of healthy landscapes that one may find the understanding of biologic change that enables us to plan for an environmentally secure future in which social purposes may find relative stability.

It is with the above thoughts and their implications that the following evaluations were designed. The proposed use, the site, and the whole of the landscape context must each be evaluated in terms of the other.

5.1 Degrees of intrusion index

In order to know what the landscape context of a particular site might be, a vast number of possible factors would have to be evaluated. Even if the inventory of the Geogram were filled in by experts, it could not convey the

essential character of a place. Although variable and imprecise, as well as arbitrary, the following subjective and impressionistic descriptions were compiled to serve as a standard basis for evaluation in Montana. Since landscapes can be perceived at many different scales, and sites can be of different sizes proportional or not to the kinds of enterprise, there is no specific quantification attached to the descriptions. The evaluator will simply have to subjectively judge, within the spirit of the intent, in order to find both a description of his site and an appraisal of the interacting surroundings within which he will operate.

5.2 Evaluation of proposed use (Pu)

Using the following outline, which is the same as that used in the compilation of the Tables of Degrees of Intrusion (which follow in 5.5), consider carefully what a description of the site would be like after the enterprise was established and functioning. After the description is written, compare it with the descriptions qualitatively outlined in the tables (5.5). Assign a number from 1 to 10 to indicate which of the descriptions is most appropriately similar to that of the proposed use. It is possible to make interpolations to the first decimal point, i.e. 7.4. This number becomes the index of the degree of intrusion of the proposed use (Pu). Enter at 5.6.

5.21 Outline of descriptive elements

The following are the key points in an ordinary description or recognition of the varying degrees to which man uses and modifies the landscape. In evaluation of the site or proposed use, only some of the entries may be applicable.

A. General Description

1. Situation, scale; the basic surroundings whose character may interact with that of the enterprise
2. Visual characteristics
 - a. linearity: randomness - order
 - b. geometric shapes: monotony - diversity;
intrusiveness - fitness
 - c. textures: vegetation, topography, cultural artifacts

- d. colors: diversity - monotony; appropriateness - expectations
- e. historical-cultural fitness, continuity of place, identity, uniqueness, coherence of structure, human occupation, land use, vegetational changes

B. Surface Alteration

- 1. Land surface, including soil, rocks, waters
- 2. Vegetation alteration. Morphology, community structure, diversity, stability

C. Human Occupance

- 1. Economic activity
 - a. agricultural density, intensity, extent
 - b. extractive industries, intensity, concentration, extensiveness
 - c. transportation net, density, proportionate traffic
 - d. residential structures, ruins, agglomerations, style - context
 - e. economic infrastructure, facilities, use, disuse, extensiveness
 - f. recreational development, seasonality, character
- 2. Intensity of use
 - a. relative amount of management input, seasonality of use
 - b. time of use - historical continuity or lack of it; newness of change
 - c. trends now detectable in use rates, concentration in spatial distributions
- 3. Sounds and smells
 - a. intensity, frequency, identity of source
 - b. consequences - solitude - loneliness - neighborliness - alienation, conversation, pain, nuisance

D. Special Situations

- 1. Uniqueness - rarity

2. Fragility - susceptibility to change
3. Key productivity points - winter ranges, wetlands, migration shelters, etc.

5.3 Evaluation of situation

Most objection to enterprises comes from their neighbors. A public sense that a degree of misfitness or local incongruity exists may relate simply to nuisance factors or it may reflect a feeling that an outrage has been committed with respect to the historic identity, perceived function, or environmental integrity of a place. It is an intuitive truism in western thought that people find good in their relation to place. Modern mobility may have made a sense of "home" a rare experience, but our traditional value structure makes this emotion an important one. For the sake of attempting to preserve or make possible the continuity of the character of place which contributes so largely to the sense of home, it is necessary for new enterprises to carefully consider the character and scale of their change in relation to the neighborhood and surrounding countryside. It is felt that an attempt to deliberately index the "wide angle view," the synthesis of the character of the local region, would have great value in a site permit scheme.

5.31 Situation: degree of intrusion

From among the following ten descriptions (in 5.5), find a combination that is most similar to the neighborhood, local countryside, or immediate region in which the intended site is located. Assign a number that best represents the position of that description in the tables. Interpolation to the first decimal is acceptable, since the descriptions are arbitrary choices from a continuum of variety. Enter the number at 5.6, after Index to situation (Su).

5.4 Evaluation of the site

The nature of the immediate site condition is important. If, for example, the site is the only remnant open or agricultural space in an urban sea of buildings, it has a great value with respect to its situation. On the other extreme, if the site is an old gravel pit or at the edge of a road in an old farming area, it has less value with respect to the neighborhood and could more readily be considered a favorable place to put a development that would seriously disturb the soil. As in the rating of the proposed use, the finding of an appropriate scale description in the following tables (5.5) makes necessary a mental scale shift with respect to some entries. The intent of this section is the discovery of any contrast

that might exist between the site and the situation which might not have appeared in any of the previous evaluations. Index the site (Si) with a number appropriate to the position of the best fitting description in the tables of degrees of intrusion (5.5). Enter at 5.6, after Si.

Degrees of Intrusion Index

The following ten subjective descriptions are sequenced so as to make it possible for an individual to index both the situation of his intended site and the changes he intends to make on that site. Evaluators must remain aware of the shift in scale that distinguishes the situation, or interacting surrounding conditions, from site, the specific description of the actual property to be modified. This index serves both kinds of evaluations.

Evaluators are expected to interpolate between the index numbers by approximation to the first decimal place, i.e. 3.4.

5.5 Degrees of intrusion index

General Description, Index-1

Situation: Wildlands, natural situation is still fundamentally unmodified by human occupation.

Visual Characteristics: There is an absence of straight lines and geometric forms unrelated to the natural shape and organization of the countryside, rock formations, streams, and vegetational communities. There are textural contrasts that conform to the scale of the landforms and result from vegetational succession in relationship to undisturbed edaphic conditions. The colors and textures of the surface cover lack human interference and are, therefore, usually greater in variety and without great sharpness of line and boundary contrast, except as they accord with season, soil moisture, exposure, or other non-human factors. The character of individual landscape features fits the scale of the site and its natural causal processes.

Surface Alteration

Land Surface: Soils and rocks have not been excavated, graded, filled, drained or cultivated by man. Streams are free-flowing, impounded only by landslides, wildlife, or other non-human processes.

Vegetation Alteration: Plant communities that have historically been overprotected from fire may be observed here, but ideally there should be no evidence of human interference with vegetational variety, growth and succession. Ground cover modification by foot traffic and light trailside grazing by pack animals may be tolerated within this classification. Wildlife population fluctuations may have been studied but not interfered with.

Human Occupance

Economic Activity: Wildlands lack agriculture, extractive industries and transport network other than trails for foot traffic. There are no structures other than temporary campsites with slight rearrangements of stones and wood or branches. There are no developments for recreational purposes other than concealed shelters, wooden hitching posts, corrals, campfire places, and cleared trails.

Intensity of Use: This is a relative term, for some wilderness areas can be intensively used with a low number of people simply walking through. Ideally, the intensity of use is low enough to make the presence of man unobtrusive. There might be more men than mountain lions, but never will there be as many men as there are deer or elk. Machines are absent.

Sounds and Smell: Wildlands should provide a lower level of sound whose identity relates to natural processes. Man-made noise is rare and very intermittent. Mechanical noise simply does not overcome the sounds of wildlife, wind and water. Wildlands should be places where human senses can be restored to a base-line perception of the non-human. Smells associated with human industry are absent. Woodsmoke is appropriate; the internal combustion engine and its fuels are not.

Special Situations

Declared Wilderness and "Primitive" areas, wildlife refuges, game refuges, State and National Parks or Monuments should automatically be indexed in this category regardless of their actual condition. Extremely fragile landscapes, such as wetlands (over two acres in size) and alpine zones near and above the timberline are also included.

General Description, Index-2

Situation: Near-wilderness or "primitive" land.

Visual Characteristics: Near-wilderness land has many of the major attributes of wild lands except that it has relatively historic temporary intrusion or change by human activity. There are no new light colored scars, alignments, or geometric shapes produced by activities such as logging, clearing for grazing or cultivation, roading or mining. One may be able to find old roads and railroads as well as angular disjunctions in vegetation community textures which indicate successional recovery from former disturbance. In this sort of a landscape one may discern a history of prior use and subsequent abandonment without consistent or recent re-development.

Surface Alteration

Land Surface: Although former roads and clearings may be detected, there should be no major soil or rock disturbance which had relatively permanent consequences on soil moisture conditions. There are no dams, canals, or terracings actively in use.

Vegetation Alteration: The history of vegetational change might not be obvious to any but the trained observer. But evidence such as stumps, straight line boundaries, some open even-aged stands, impoverished plant communities, brush thickets along drag and fire lines, or the re-vegetating scars of a former period of accelerated erosion may be sufficient indicators of a previous change that is now healing. Much of the distinction between 2 and 3 rests upon the scale of the former change. If more than a third of the whole landscape unit or drainage basin was clearly affected, then it does not belong in Class 2. Over-protection from fire may be evident as might heavy summer grazing by stock.

Human Occupance

Economic Activity: There is no evidence of active current agriculture, not even tree-farming. The former transportation network is not now trafficable by motor vehicles (ATV's and snowmobiles excepted). Evidence of present traffic is confined to trails, grazing corridors, or localized recreational impacts. There are no new structures. Ruins of former pursuits such as apple trees and rhubarb, miner's cabins, head-frames, sawmills or railroad bridges may be present as isolated instances. Recreational development is minimal and limited to seasonal facilities of an impermanent nature.

Intensity of Use: Lightly used, the land has had more use than land in Class 1, but presently has no permanent residents and may be empty of men for long periods of time. Stock grazing does significantly increase the intensity of use. Management of the area is light, chiefly restricted to fire control and reasonably effective control of the grazing.

Sounds and Smells: Mechanical noises are weak and intermittent. The opportunity for solitude and sense restoration are no different from Class 1, except, perhaps, for the presence of stock.

Special Situations

Some historic landscapes may be involved. It is possible that a few remnants of distinctive plant communities such as short-grass prairie may be identifiable and recoverable under protection of this classification. The same might be said for some of the ponderosa pine bottomlands that have been logged and kept from returning by grazing. Land such as has been described should be kept in open space for non-mechanized recreational purposes, game management, and watershed protection.

General Description, Index-3

Situation: Lightly domesticated range, forest, and agricultural land.

Visual Characteristics: Man has built corridors through and has parceled up the land so that there is a low density of linear patterns of roads and field boundaries indicated by differing textures and colors of vegetation. Heavy grazing or differential use histories appear as disjunctions along fence lines. Although cultivated areas are discernible, they occupy less than half of the landscape unit and may be said to conform to the topographic elements of the landforms. Mature trees, old structures, and well vegetated spaces give a sense of historic continuity to the light human occupation of this land.

Surface Alteration

Land Surface: On small portions of minor landforms such as river terraces, soils may have been disturbed for cultivation; gravels and rocks in a few locations may have been mined. The whole of the obviously disturbed surface does not constitute more than 30% of the total scene. Roads and irrigation canals exist, but at a low density without major land excavation. Spoil dumps and tailings are not continuous; neither do individual ones occupy more than an acre. There may be dams, ponds, canals in use.

Vegetation Alteration: At least half of the scene is close to the potential natural plant community, whether it be forest, marsh, shrub or grassland. Up to half may be in managed range or cultivation in an extensive manner, such as hay, timber trees, or pasture. Occasional grain crops may be in evidence, but less than 20% of the land is clean tilled in any one year. Distributions of native as well as domestic plant species can be related to agricultural technology--as in lines of cottonwoods along a ditch, or at the break in slope where a sharp line is caused by plowing.

Human Occupance

Economic Activity: Agriculture and animal husbandry of a light intensity is fitted into a landscape with many remnant features of our historical frontier. Extractive practices in logging and mining may well be evident, but they do not dominate the area, largely because they were of a different scale, limited to small portions of particular landforms and not massive and rapid in execution.

The transportation network operates with modern vehicles at about 10-mile intervals. There are no freeways.

Farmhouses and outbuildings or occasional special structures such as sawmills or powerlines are present, but aggregations are no larger than hamlets with populations of about 100.

Recreational development of a seasonal character, such as summer dude ranches, ski areas, or hunting lodges probably are present.

Intensity of Use: Management of the whole landscape is only locally or seasonally intensive, in the small portion of land actually cultivated or being mined. The area may be in the process of losing population, but shows an historic continuity of occupation and stable economic context. It lacks the presence of modern industry, showing, rather, a landscape that is slightly anachronistic in relation to more intensively farmed and less remote areas.

Sounds and Smells: There is still opportunity for solitude. Mechanical noises are frequent, but still intermittent and never dominant. To the natural sounds of movement are added those of cattle and passing traffic as well as farm machinery in season. Wildlife may be seasonally abundant as a result of the ecotones created by human disturbance. There is a greater variety of smells, many of them characteristic of the occupations, but none dominate or deaden the senses.

Special Situations

The Montana western ranching landscape is unique in the world; some could be saved!

General Description, Index-4

Situation: Medium density range, forest, and agricultural land.

This category is most useful at the scale of major topographical units, such as valleys.

Visual Characteristics: The land is more or less continuously occupied, nearly every square mile will have some linear mark on the surface: straight lines mark property boundaries, ditches, power lines, roads, or a history of vegetational disturbance. Angular shapes made by such lines are common, the result is a patchwork of differing colors and textures. These contrast sharply with the approximately 40% of the scene that remains without such features of cultural origin. In an historico-cultural sense, one may perceive that the landscape has been well domesticated, representing agricultural settlement of at least two generations. Farmsteads may be dispersed or clustered. Much of the landscape will be marked by clumps or lines of planted mature trees. Few new residences or other signs of recent subdivision accent the scene.

Surface Alteration

Land Surface: Soils may have been prepared for cultivation by several techniques, including leveling, draining, irrigation, or plowing. Approximately 60% of the arable land has been tilled at some time, although 70% of the farmland may actually be in some permanent cover. Of the whole situation, one could estimate 40 to 50% of the land is still basically unmodified, although the vegetation may have been changed. Disturbance by mining will have left scars on minor landforms, never dominating any major portion of the landscape, such as valley floor or an entire mountainside.

Vegetational Alteration: Even in the relatively natural portions of the landscape the composition and successional position of the plant communities has been altered. Grazing, fire, logging, species introduction or wildlife population changes have made substantial alterations. Most range and forest experts would call it good, although individual properties in the surrounding areas may be overgrazed. The alterations are not so profound as to have induced raw and open gullying or noticeable increased stream sediment loads. Most of the land is adequately covered with a diversity appropriate to variations in its edaphic conditions. The introduced vegetation consists of several crops, ornamental and fruit trees. Wetlands and slopes bear remnants of potential natural vegetation.

Human Occupance

Economic Activity: Agriculture dominates. Small units of agricultural processing and warehousing, connected to transport lines are characteristic. Residential and farm structures

are dominant. Agglomerations are small, between 300 and 2000 in population. The major structures relate to agricultural pursuits, schools and sports.

Intensity of Use: In Montana this is difficult to express, for units vary considerably in size from one region to another. In ranching country units may be 5 to 10 miles apart. Valley landscapes may have farmsteads at one- or two-mile intervals. Road networks may be only a mile apart along the central corridor. Residence is apparently permanent. Populations are stable.

Sound and Smell: Mechanical sounds of human activity begin to dominate during the working hours. Smells of machinery and agricultural processing are distinctive enough to be noticed, but they do not dominate.

Special Situations

The recreational potential of this landscape is high. Careful attention should be given to the preservation of small units of wetlands and remnant stands of natural vegetation. Interruption of stream flow in such a situation may seriously affect populations of wildlife. The margins of these disturbed sites may be important winter ranges.

General Description, Index-5

Situation: Predominantly agricultural land.

Visual Characteristics: Under most conditions, this landscape is more visually monotonous than the preceding, largely because the entirety of the landscape has some linear or geometric mark of human occupancy, whether it be fence lines, dry farming strips, highways and power lines or angular roads zig-zagging across slopes. Signs of occupation are absent only in small depressions or in the shelter of forests. Whether used for farming, forestry or ranching, the scale of the linear markings dominates that of the topographic texture of the landscape.

Surface Alteration

Land Surface: No less than 20% and no more than 80% of the land surface has been modified lightly by plowing, leveling, or irrigation. If the landscape is reasonably flat, the cuts and fills of the transport system are noticeable, as are the spoil dumps and tailing ponds of mining activities. Major soil and rock disturbances are, however, confined to small portions of the landscape in units smaller than five acres.

Vegetational Alteration: There may be less than 20% of the potential natural vegetation in recognizable form. Agricultural activities, including grazing, have modified the species compositions, cover and character. Substantial portions of the landscape have been reduced to an artificial uniformity by a variety of techniques. Generally the range would be classed as good. Woodlots or other clumps of forest are scarce and discontinuous in the Eastern slopes and obviously managed in the Western part of the State.

Human Occupance

Economic Activity: Farming, ranching, forestry predominate. The transportation network may actually be less developed in intensity than that of Class 4, but is heavily oriented to corridors which may have freeways, highways and railroads on parallel routes. Normally the network intervals are 3 to 10 miles apart, except within 3 miles of the main corridor. Residential structures either form parts of agricultural complexes or are clustered in small to medium sized towns with a population of 500 to 8000. Agricultural processing and warehousing structures may be distinctive. Modest highway service and urban retailing or service structures are concentrated.

Intensity of Use: In Montana, low population densities prevail even though it is clear that the land is intensively used within its limited potential productivity. Farming, ranching, and even forestry practices are attempting to use most space up to and occasionally beyond its limits. Observation of overgrazing, accelerated erosion, silt-laden streams, bare ground, and heavily browsed stream-side shrubs are indicators of heavy use.

Sounds and Smells: Mechanical noise is seasonal and sporadic, and with the exception of those areas near the transport corridors, largely absent at night. There is an absence of industrial smells.

Special Situations

There may be valuable stream and aquatic environments which could be adversely affected by either addition or subtraction of irrigation waters. Highway oriented developments could conceivably seriously alter the character of the landscape as perceived by both tourist and resident. Some kinds of development, such as recreation, might well restore cover and variety to abused agriculturally used land, as well as to places once mined or logged.

General Description, Index-6

Situation: Occurring in smaller situation, this is a clustered or nodal semi-rural residential class. Topographic units or well-defined combinations of limited urbanized clusters may be included here.

Visual Characteristics: Although the surrounding countryside may legitimately be a 4 or 5, the transport corridor with lateral linkages provides a continuity to clusters of settlement which are distinct units. Many of them may be satellites of some major urban area, others may be recreational developments of a unified residential or destination variety. Within the topographic unit occupied by the settlement there may be a strong contrast between the highly developed and circumscribed urban area and the clearly rural surroundings. The whole of the landscape may be linked by roadways, yet efforts have been made to keep a large amount of the slope land in a "natural" state. Within the urbanized area at least 40% of the space has been devoted to gardens and lawns, or left with previous trees. The linear and the geometric have been concentrated. Where dispersed, efforts have been made to hide the intrusion through diffusion of sharp edges, restraint in excavation, in color and texture contrast as well as in skyline protrusion.

Surface Alteration

Land Surface: Within the urbanized area at least 60% of the surface has been excavated, sealed, or otherwise relatively permanently altered. Outside of the settled area, about 30% of the land surface has been altered by plowing, irrigation, or vegetation removal.

Vegetation Alteration: Within the settled area plants are introduced and cultivated. Outside, the characteristics are normally those of a 4 or 5. There is a tendency to maintain non-agricultural areas for scenic or recreational use in a state that approximates the potential natural condition, a matter that varies according to the past history of the site.

Human Occupance

Economic Activity: Residential and recreational, even with some amenity kind of agriculture carried on. Some restrained and planned land speculation is involved with the development of this type of settlement. Except for the main trunk lines, transport developments are inconspicuous. The buildings are primarily residential, except for the minimal service and retail structures of the settlement node. Special purpose recreational and remnant agricultural structures may identify activities outside of the centers. There is an absence of highway oriented service development, and obviously industrial structures. Airports and playing fields are evident.

Intensity of Use: Seasonally high use of the countryside at low densities for non-consumptive purposes is characteristic. The residential areas are compact and achieve high densities in the locally circumscribed area. Taken as a whole, the landscape unit has a low density, but a great deal of contrast in use intensity.

Sounds and Smells: Background noises are largely natural, except for peak traffic periods within the urbanized area. Human noises such as children playing or fighting form a distinctive part of the neighborhood background. Rural sounds and smells prevail most of the time.

Special Situations

This kind of amenity residential settlement is the trend of the future, given the kind of laws that will make possible the localization of densities and tight control over sprawl. The advantage to the vegetational cover of the countryside as well as to the efficiencies of urban transport, utility supply and waste disposal should be apparent. With careful noise and emission controls it should be possible to integrate some industrial activity with such a landscape.

General Description, Index-7

Situation: Suburban agriculture or rural residential, this class often represents an extension of bedroom suburbs into the countryside. It may also represent the subdivision of agricultural landscape into residential retirement or amenity agricultural functions as well as some intensive market gardening. Abused agricultural land fits well into this situation.

Visual Characteristics: Usually a valley plain or some other corridor junction area. Nearly all of the least slope land is unevenly divided into garden farms, fields, and lots that may range from one-quarter acre to five acres in size. The linearity of settlement parallels the transport networks; the scale of the resulting cluttered geometric pattern changes with proximity to more fully urbanized areas. There may well be striking contrasts in unit size between the near-highway area and the distant mountains or hills. The texture of the subdivision is not as uneven along the main corridor or axis as in Class 6. Settlements are not concentrated; there may be only a few diffuse nodes of incipient retail and service function. Remnants of a prior agricultural pattern reveal that the newer residential structures are filling in the spaces with busier textures, newer and brighter colors. The continuity of occupation and landscape identity is in the process of being broken to a new, automobile-centered suburban pattern. Visually jarring incongruities of new and old, signs and views, demonstrate the newness of a developing area.

Surface Alteration

Land Surface: Within the newly developing region most of the land surface has been cultivated. The continuity of even the minor landform surfaces has been altered by leveling, ditching, cutting and filling or other kinds of heavy use impacts such as grazing. Only a few corners or floodways or locally steep slopes remain undisturbed. The disturbances of mining have either been largely obliterated or have prevented this pattern of development.

Alteration of Vegetation: Very little of any "natural" vegetation remains. The pattern of the former occupance can be discerned in the alignments of the older trees. Crops and pastures are nearly all cultivated. The newer patterns of cultivation and animal keeping are on a smaller scale than the old, thus the patterns are usually disjunct, with considerable age contrast over a short distance. There may be a greater diversity of plants, but the greatest proportion of them are ornamental.

Human Occupance

Economic Activity: Marginality of activity is implicit in the previous description. There is some turnover gain from real estate speculation, but, except for market gardening and dairying, the area is no longer primarily productive. The transport net is rapidly becoming more intricate, as is the supply of basically urban services. Structures are mostly residential, with smaller scale imitations of the traditional rural outbuildings. The landscape becomes crowded with rather obtrusive and temporary structures. Some kinds of rural industries are present: chicken and egg factories, mink farms, horse breeders and trainers, small meat packing plants, etc. Highway service facilities are diffusely focused; branching crossroads are incipient nodes for suburban services.

Intensity of Use: The area is intensively used especially along the corridor, but diminishes towards the sides and ends distant from the nearest urban area. Overall densities may be light, but the countryside appears crowded because of the strip development and lack of concentrated settlement. As the intensity of settlement increases, the original amenities disappear, causing leapfrogging development and lateral extension of urban sprawl.

Sounds and Smells: Only at the margins is there an absence of the noise and smell of the traffic. Some peaceful islands, isolated by topography, water, or large properties exist and are valuable.

Special Situations

The unique remnant open spaces with vegetational or topographic isolation from development could be better preserved early before urban reclamation becomes necessary. Water and waste treatment or supply is often a problem.

General Description, Index-8

Situation: This class includes land developed into a high quality urban situation. The dimensions of the surroundings must be judged on a neighborhood scale, a unit usually much smaller than would be used for evaluation of, say, a primitive area.

Visual Characteristics: This is a high density urban area in which man-made forms dominate. Judicious use of architectural and landscape design principles has provided a number of visual elements which reduce the contrasts between the perceptions of individual persons and the scale of the buildings or the street network. The presence of trees and other vegetation provides both color and textural relief as well as a breakup of excessive linearity and repetition in structure and surface. Whether in commercial business district or lower density suburb, the conventional emotional response of the viewer is that "this is a nice place to be."

Surface Alteration

Land Surface: Nearly the entire surface has been highly modified. Cuts and fills for streets, sewage and utility lines have altered drainage and runoff patterns. Surfaces have been reshaped to accommodate structures.

Alteration of Vegetation: All of the vegetation is permanently cultivated; most of it is exotic. Plant cover, including lawns, is no less than 30% and no more than 70% of the total surface area.

Human Occupance

Economic Activity: Commercial agriculture is absent; gardening and park tending may yield indirect economic returns as amenities. The range of urban economic activities is great. There is no reason why clean, quiet industry should not mix with commercial, retail and residential urban activities. In normal American practice, however, this class will contain only the most exceptional industrial activities. Cemeteries are normally included, as are carefully planned community center recreational areas in all-year use.

Intensity of Use: High and permanent.

Sounds and Smells: Background noise should never be over 40 to 50 decibels. Noise over this level inhibits ordinary conversation and contributes to annoyance and distraction. Smells are, hopefully, characteristic of the immediate neighborhood, not from some adjoining district.

Special Situations

Open space is always in short supply. Unique features such as rivers, river banks, hillslopes, or wetlands ought to be preserved as islands of visual and ecologic contrast for purposes of sensory renewal as well as for aesthetic perception.

General Description, Index-9

Situation: Ordinary urban situations, as well as some smaller units of heavily abused rural land are so permanently altered as to have very limited options for biotic reclamation. Small neighborhoods or sites are usually involved. Some extractive operations have left scars on the scale of hundreds of acres.

Visual Characteristics: Completely modified and altered by man, this landscape is dominated by buildings, signs, habitations, and pavement. The linearity of the visual environment is extreme. It is an almost completely humanized landscape in which very few of the forms are recognizably "natural." The mined land, whether unreclaimed spoil dumps, tailing ponds, or the non-revegetating clearcuts, has been seriously altered within reasonable human time. The texture of the view is a striking contrast with the surrounding countryside. Colors are not as varied as those in Class 8, but are more diverse than those of Class 10. Vegetation covers 10 to 40% of the unit area.

The normal visual response of an American to this kind of neighborhood, whether residential or downtown commercial, would probably be "it's ok, but I've seen better."

Surface Alteration

Land Surface: Very nearly sealed by streets, buildings and the excavations for foundations, sewers and utilities; reclamation of these lands would involve a major long-term expense and commitment. Drainage has been altered and permeability impaired.

Alteration of Vegetation: All native vegetation has been removed. The cover that does exist is all permanently cultivated with the exception of the untended weeds on empty lots. The number of species is very reduced, especially in comparison with preceding classes.

Human Occupance

Economic Activity: Highly diverse, but segregated into largely single-function neighborhoods or districts. Zoning structures perpetuate the spatial separation, as do the results of previous environmental change. The unrecuperating clearcut is similar to that of the low density suburban community or the low density small town central business district. Light industrial areas with considerable variety (relative to other industrial zones) may be included in this class.

Intensity of Use: High and permanent, but relatively light density of population for urban commercial areas. The population density of mined land is, of course, low. Activity may be nil, since such extractive activities can only be abandoned if reclamation fails. If there is no hope of reclamation within a generation, the land should be placed in Class 10. Urban quality may not be on the upswing.

Sounds and Smells: Offensive sounds and smells are usually daily occurrences. Noise levels are commonly above 40 decibels on the open street. Conversation and sense perceptions are inhibited, distracted and made difficult.

Special Situations

Opportunities to obtain open space or to increase the amount of planting should be taken. Restriction of noise and increase of foot traffic can stimulate diversity of urban function and lead to an improvement of urban quality through development. Major efforts to reclaim mined land may not be worthwhile in the short run. Conversion to wilderness is impossible, some other high intensity use could be sought. Revegetation is important to streams and to aquatic life.

General Description, Index-10

Situation: This usually is a smaller region, in size up to a few tens or hundreds of acres. Heavily urbanized land or completely altered land, such as that under mine dumps and tailing ponds, is at this end of the scale unless unusually large investments are made. The costs and physical difficulties involved in a reclamation to some biologic productivity is nearly impossible within two generations.

Visual Characteristics: There is an obvious lack of vegetation. The land is either bare and ruined for major forms of plant life or is covered with structures and pavement. Heavily polluted areas, mined out areas, heavily eroded or farmed-out lands, and urban-industrial slums are included. Neighborhoods are even in texture of building size. The contrast of man to structure scale is great (as one would feel while walking under a freeway interchange). Lines, monotony of geometric forms, unrelieved repetitious pattern of surfaces, uniformity of color, and absence of sky variations may be characteristic.

Surface Alterations

Land Surface: A maximum of change, ranging from soil removal to emplacement of rubble has occurred. Interference with growth processes through moisture deprivation, interruption of capillarity or permeability or even through poisoning may have, for all practical purposes, nearly destroyed the biologic potential.

Alteration of Vegetation: Only the hardiest of weeds or a few struggling cultivated species survive. Plant cover is less than 15% of the ground surface within the unit.

Human Occupance

Economic Activity: A wide variety of commercial and industrial activities, excluding all but the poorest of the residential slums.

Segregation of activities took place in response to the environmental degradation caused by the activities. Many of the places are populated only by day or only by night. Amenities are virtually non-existent.

Intensity of Use: During the working hours and in the residential areas the densities are high and the intensity of use is quite variable. Many areas within industrial sectors are used for warehousing and transportation only, but very active areas are in transit corridors.

Sounds and Smells: The smells are pungent and confusing as to source and identity. Natural odors are overwhelmed. Working hours develop background noises in excess of 70 decibels; sometimes working environment noises exceed 100 decibels. Conversation is nearly impossible.

Special Situation

Open space with vegetation has an extremely high value in this kind of a situation. New construction should reserve a high percentage of space for planting or other reclamation.

5.6 Comparative evaluation of site, situation and proposed use

Enter index for proposed use (Pu) _____

Enter index to situation (Su) _____

Enter the index to site (Si) _____

5.61 If no difference between the three exists, enter zero _____.

5.62 If differences exist, apply the following formula:

$$(Pu - Si) + (Su - Si) + (Pu - Su) = \text{index of intrusion} \underline{\hspace{2cm}}.$$

Negative scores indicate possible improvement of the site or situation by the enterprise. Positive index numbers betray a possible degradation of either site or situation or both.

Enter the index number at 9.562 on the land evaluation summary sheet.

5.7 Total intrusion score

Because the preceding evaluation is essentially qualitative, indicating direction of change only, a full evaluation requires some indication of magnitude. Therefore, the index of intrusion above (5.62) is multiplied by the total disturbance score which may be found at 3.34 or at 9.334.

The product should be entered at 9.57 on the land evaluation summary sheet.

6.0 Aesthetics

One of the most difficult subjects to treat effectively in an Environmental Site Permit System is aesthetics. However individualistic we may be in our opinions about likes and dislikes in scenery, the overall behavior of society clearly demonstrates the importance of aesthetics and amenities. The vacation destination and route is normally decided by a mix of aesthetic and economic criteria. The choice of a place to live and the decoration of it has substantial aesthetic overtones. One of the important aesthetic emotions is the appreciation of the visual elements of the immediate personal environment. Artists and industrial psychologists, efficiency experts and landscape architects all bring the testimony of trained minds and experience to confirm the importance of aesthetic perception in human behavior.

After considerable uncertainty and search for alternate methodologies, it has seemed best to judge the natural quality of the site and the aesthetic value of the area immediately surrounding it by use of the Degrees of Intrusion Index (5.5). The types in that index classify a graded series of likenesses which ranges from "Wilderness" (1) to "Heavily Urbanized" (10). These units index the degree to which man has modified the landscape, the fitness or misfitness of some of these man-made changes, and rank the irreversibility of these changes.

This kind of an approach gives a special emphasis to change through time. It makes clear the realization that land use is not and cannot be static, but, rather, is ever-changing under man's presence and manipulative influences.

A sense of the aesthetic quality of the landscape has been linked in this evaluation to the conviction that irrespective of cultural styles in land appreciation, more options are saved if certain less disturbed portions of the landscape are maintained in a state nearer to the natural end of the scale. Already seriously disturbed areas may be better able to suffer the changes that accompany the diversities of public taste.

In an environmental evaluation of aesthetics, at least two basic kinds of potential changes can be considered: the immediate and direct as compared to the indirect and more subtle results of accumulated small actions. The first relates to the development of the particular site which it is intended to change. The other more often relates to the effect of that development on the whole situation, the landscape in which the development will take place.

One may also attempt to discriminate between changes to the aesthetics of the cultural environment and those of the natural

landscape. This sort of division is artificial and usually inappropriate. But in Montana there is much more "nearly natural" scenery which contributes greatly to our sense of identity. Therefore, a portion of the evaluation based on the elements of the physical "natural" landscape is thought especially useful, when the changes to be made on the site, compared to the changes that exist in the neighborhood, are significant. Evaluation of any kind of aesthetic change in the more wholly cultural environment of an urbanized area is very difficult. Certainly it is not limited to the functional descriptions on which zoning ordinances are usually based.

6.1 Evaluation process

Although based on the same reference points (the degrees of intrusion descriptions), this evaluation has the advantage of attempting a more precise definition of the site, its neighborhood, and the public view. It will be necessary to read the degree of intrusion tables (5.5) with aesthetic possibilities in mind. The outline of landscape elements to be considered (5.21) is the same at that for intrusion, but greater emphasis should be placed on the visual qualities as well as on the sounds and smells sections. Indexing for aesthetic purposes from the descriptive degrees of intrusion demands selective judgment.

6.11 Map

Outline the site on a suitable map. Overlays on aerial photographs would be satisfactory. Any scale smaller than 1:24,000 is not likely to be satisfactory. Scales in the range of 1:500 to 1:24,000 are best. Submit with the evaluation application.

6.12 Evaluation point (EP)

Find a suitable point from which to conduct the visual evaluation with the following considerations in mind:

- a. It must include a view of the site.
- b. It must include a view of the neighborhood to be affected by the proposed development.
- c. It must be a view seen by the public, i.e. the most traveled public road, the greater number of neighbors, etc.
- d. It must be close enough to the site so that the Degree of Intrusion (DI) or the average degree of intrusion (ADI) can easily be ascertained.
- e. The evaluator should choose the best, rather than the worst view within the limitations of the above

conditions. He should intuitively seek the place with the highest quality view.

- f. The evaluation point can also be considered a 100-foot radius circle within which the evaluator can move about. Because of such difficulties, especially within urban areas, the finding of an evaluation point may involve several trials, including the search for a neighboring high point.

Indicate on the map the location of the evaluation point (EP).

6.13 Determination of the immediate impact area

A more precise definition of situation, made with visual and audible aesthetic factors in mind, the Immediate Impact Area should never extend more than a mile from the evaluation point.

- a. The Immediate Impact Area should be that land adjacent to the site which has the greatest effect on the viewer's impression of landscape identity and quality.
- b. In some cases it may be necessary to include within the Immediate Impact Area those areas in a visual or air movement corridor which might be affected beyond the one-mile limit.
- c. On the map (6.11) demarcate the approximate perimeter of the Immediate Impact Area. Make sure that it includes the evaluation point and the site.

6.2 Evaluation of degree of intrusion (DI)

Although based on the same principles as the previous index of landscape quality, the following method allows a somewhat more precise and specific indexing of description. It is possible to divide both the site and the Immediate Impact Area into sections of differing qualities. A procedure is offered for the averaging of these qualities.

- 6.21 Using the map (6.11 and 6.13c), draw lines which seem to divide the site into areas which, judging by their appearance, will have different degrees of intrusion index numbers. This need not be done if the site is uniform. Assign to each an appropriate index number from the degree of intrusion tables (5.5).

- 6.22 On the same map draw similar lines which segregate the Immediate Impact Area into areas of differing levels of intrusion. If the whole of the impact area looks very similar, there is no need to do this. Assign to each area an index number based on the degrees of intrusion tables (5.5).

6.23 Either by visual estimate or by use of a polar planimeter determine what percentage of the site is covered by each of the different categories. The total should be 100%.

6.24 Either by visual estimate or by use of the polar planimeter determine the percentage of the Immediate Impact Area covered by each of the mapped categories. The total should be 100%.

6.25 Averaging of index numbers in proportion to area covered

For the site, multiply each degree of intrusion index number by the percentage of the total site it occupies. Then sum the totals to obtain a proportional average index of the degree of intrusion present. Enter the index number at 9.625a.

For the Immediate Impact Area, repeat the same procedure as above. Enter the index number at 9.625b.

6.3 Estimation of change using the index to degree of intrusion (DI)

By carefully considering the plans of the proposed development, including especially such factors as landscaping, architectural continuity of style and the probable intrusiveness or scenic disruptiveness, make a new evaluation of the proposed use, which can be called the predicted degree of intrusion for the site. Assign it an appropriate index number. Enter the number at 9.63.

6.31 Subtract the present DI index number from the predicted DI for the site. Enter at 9.631.

6.32 By making a deliberate attempt to visualize the impact of the developed enterprise on the neighborhood character through the potential change in appearance, traffic, function, sound and smell (especially those aesthetically related items on the outline at 5.21). Estimate the DI of the Immediate Impact Area as it would be after the proposed enterprise was established and functioning. Enter this predicted DI for the Immediate Impact Area at 9.632.

6.33 Subtract the present impact area DI index number from the DI predicted for the Immediate Impact Area. Enter the difference at 9.633.

6.34 Subtract the present DI for the site from the present DI for the Immediate Impact Area. Enter the index number at 9.634.

6.35 Add together the differences (both positive and negative numbers) resulting from the operations in 6.31, 6.33, and 6.34. This is the Index to Predicted Aesthetic Quality Change.

6.4 Alternatives

6.41 If the final total is below +1, a total quality impairment score of zero may be entered at 9.641.

6.42 If the sum (6.35) is +6 or over, then a quality impairment score which is the square of summed index numbers should be entered at 9.642. A score over 36 should indicate to the developer and the public that serious changes are likely to occur and should, therefore, be brought to neighborhood attention. This also means that evaluation of the natural landscape quality (7) must be included.

6.43 If the summed index number differences (6.35) lies between +6 and +1, the number should be entered at 9.643 and be carried over for use in the evaluation of the natural landscape (7).

7.0 Natural Landscape Quality Evaluation

In cases that seem certain to cause considerable disruption of landscape character and quality, it becomes necessary to make a more considered systematic evaluation of the Immediate Impact Area. As suggested above, one means of determining the necessity for such an evaluation is a score of over +1 from the Index to Predicted Aesthetic Quality Change (6.35).

7.1 Rationale

The basic premise of this evaluation is that a greater diversity and contrast in the natural landscape will, within limits, prove more aesthetically valuable to the observer. No points are subtracted for dullness and mediocrity; such landscapes simply do not score as high. No attempt has been made to classify ugliness. No value judgments are made, for example, as to whether water has more natural attractiveness than trees. Only natural features are rated, but obviously, the culturally modified vegetation, impounded waters, and modified landforms must be included. The system avoids architectural style preferences by avoiding the issue entirely. Man-made features are evaluated according to the percentages of the total vista they comprise.

7.2 Method of evaluation

Landscape features are given index points in proportion to their presence in the view. It is an estimating, not a measuring process. For the sake of simplicity, the evaluation should be made from the evaluation point (definition is at 6.12).

7.21 Relief

For the purposes of this evaluation relief is the difference between the low point and the high point actually seen in the view from the evaluation point. Since the effect of vertical relief diminishes with the perspective of distance, the table below attempts to account for the dramatic impact of a close mountain view. The evaluator should use a map to discover how far away the most effective pair of high and low points are. Enter the points at 7.5.

TABLE VI

Relief Index

Approx. greatest distance to highest point (more rarely to the lowest point)	Number of feet (meters) of local relief between the highest and lowest points			
	Index points			
	1	2	3	4
Less than 5 miles (8km)	300-1000' (90-304m)	1000-3000' (305-914m)	3000-5000' (915-1525m)	5000'+ (1525m)
5 to 15 miles (18-24km)	1000-3000' (305-914m)	3000-5000' (915-1525m)	5000-7000' (1525-2150m)	7000'+ (2150m)
15 to 30 miles (25-48km)	3000-5000' (915-1525m)	5000-7000' (1525-2150m)	7000'+ (2150m)	
Over 30 miles (48km)	5000-7000' (1525-2150m)	7000'+ (2150m)		

7.22 Distance

Even though it may seem contrary to the assumption of the preceding table, it is recognized that part of the character of the western landscape is the opportunity to view great distances--and the sense of space thereby perceivable. The following table assigns points in proportion to the greatest visible distance. This may be determined from a map if the view is obscured on the evaluation day by normal natural weather conditions. The view is from the evaluation point. Enter the points at 7.5.

TABLE VII

Distance Index

Index points	Greatest distance seen
1	2 to 5 miles (1.6-8km)
2	5 to 12 miles (8-19.3km)
3	12 to 20 miles (19.3-32km)
4	20 to 50 miles (32-80.5km)
5	over 50 miles (80.5km+)

7.3 Unique natural forms

Diverse sorts of landmarks are common reference points in everyday life.. Some are man-made, most are distinctive in form, location, origin, texture, or color. Isolation of single examples is the distinction important to feature-dominated landscapes. A rough attempt to account for the possibility of the existence of significant features follows. Enter one point for each notable feature in the landscape. Enter two points if the form is dominant or unique enough to be considered a local tourist attraction. Do not enter more than four points.

TABLE VIII

Natural Forms^a Index

Single features	Highly unique features	Massive or dominant forms
Isolated tree, or clump of a kind	Rare plant community	Great badlands
butte, small mesa	hot springs, geysers	extensive breaks
isolated hill	event-related features	large features that
patterned outcrops	anachronisms-survivals	intrude or dominate
cliff, escarpment	Especially fine	the horizon.
incised meander, gorge	examples of geomorphic	Mission Mountains,
ripple marks, old	forms; i.e. perfect	Sweetgrass Hills
beachline	cinder cone, advancing	seen from plains.
tarn, waterfall, etc.	glacier	

^aThese are only examples of the kinds of features to be considered.

7.4 Analysis of view

In the following five evaluations the underlying assumption is that the optimum range of diversity in landscape view elements lies between 30 and 70%. Although this assumption has not been subjected to rigorous field testing by the Site Permit staff, studies by Ervin H. Zube of the University of Massachusetts School of Landscape Architecture and Regional Planning have shown that, given a sequence of photographs, most people will choose those scenes with 30 to 70% tree cover as more attractive than scenes with more or less tree cover, other things being equal. The percentage cover in the following evaluations is determined by horizontal rather than vertical view measurement, with no points given for scenes covered totally by any one element. Man-made features are excluded in determining the

percentage cover. This system does exclude appreciation of the extraordinarily uniform landscapes such as horizon-to-horizon wheatfields or the unrelieved monotony of a flat plain.

7.41 Percentage of tree cover in the vista

TABLE IX

Percentage of tree cover in the vista	Index
Trace to 1% or 99 to 99.9%	1
1 to 10% or 90 to 99%	2
10 to 30% or 70 to 90%	3
30 to 70%	4

7.42 Percentage of grass and short shrub cover in the vista

TABLE X

Percentage of grass and short shrub cover in the vista	Index
Trace to 1% or 99 to 99.9%	1
1 to 10% or 90 to 99%	2
10 to 30% or 70 to 90%	3
30 to 70%	4

7.43 Percentage of rock, bare soil, or sand cover in the vista

TABLE XI

Percentage of rock, bare soil or sand cover in the vista	Index
Trace to 1% or 99 to 99.9%	1
1 to 10% or 90 to 99%	2
10 to 30% or 70 to 90%	3
30 to 70%	4

7.44 Percentage of water cover in the vista

TABLE XII

Percentage of water cover in the vista	Index
Trace to 1% or 99 to 99.9%	1
1 to 10% or 90 to 99%	2
10 to 30% or 70 to 90%	3
30 to 70%	4

- 7.45 Percentage of snow and ice in the vista (in late summer or early autumn)

TABLE XIII

Percentage of snow and ice in the vista	Index
Trace to 1% or 99 to 99.9%	1
1 to 10% or 90 to 99%	2
10 to 30% or 70 to 90%	3
30 to 70%	4

7.5 Evaluation summation

Add together the entries from 7.21 to 7.45. The total represents the score for the natural landscape quality.

Relief (7.21)	_____
Distance (7.22)	_____
Uniqueness (7.3)	_____
Percentage tree cover (7.41)	_____
Percentage grass and shrub cover (7.42)	_____
Percentage of rock, bare soil or sand cover (7.43)	_____
Percentage water cover (7.44)	_____
Percentage snow and ice (7.45)	_____
 TOTAL	 _____

Enter at 9.75 if the index to Predicted Aesthetic Quality Change was over +6. If that number was between +1 and +6, find the appropriate score for natural landscape quality in the table below.

7.6 Relative natural landscape quality score

In this section an attempt is made to relate the Predicted Aesthetic Quality Change to the significance of the quality of the situation. The scoring tends to emphasize the greater value of the high quality natural landscape, but may not always adequately account for changes in the cultural character of a place. Reliance for that is placed on section 8 and the public involvement of knowledgeable residents.

7.61 Scoring the combined indexes

The relative predicted natural landscape quality score is found in Table XIV at the intersection of the index to Predicted Aesthetic Quality Change and the natural landscape quality score range column. Enter at 9.76.

TABLE XIV

Natural Landscape Quality of the Vista

Index to Predicted Aesthetic Quality Change						
	0-8	8-13	13-18	18-23	23-28	over 28
1-2	0	4	8	12	16	20
2-3	4	8	12	16	20	24
3-4	8	12	16	20	24	28
4-5	12	16	20	24	28	32
5-6	16	20	24	28	32	36

8.0 Historical Landscape Significance

The utilization of any parcel of land brings with it certain obligations. The restraints inherent in such obligations have seldom been fully observed and many times not even recognized. It is one of the main purposes of the ESPS to bring these obligations to the attention of the enterpriser. This section specifically concentrates on two obligations: (1) the obligation of the enterpriser to evaluate the impact of his development on the regional landscape, especially one of particular uniqueness, and (2) the obligation of the enterpriser to evaluate the historical significance of his site.

The Big Sky Country is an apt slogan for Montana. The expanse of the valleys and plains, and its mountain views are unique and beautiful. Where lightly domesticated by man, Montana landscapes are something rare in the world today, ours to preserve by historical chance. These spaces may prove to be one of Montana's most lasting valuable resources. Montanans have a great advantage not prevalent elsewhere. With some restraint, pride in regional and local identity, and a modest limitation on "the right to do as you damn well please with private property" future generations may know the joy and freedom of an open beautiful view. Montana must see to the maintenance (and repair) of its landscape qualities. In an increasingly urban world, Montana's landscape heritage is easy to lose. Therefore, we feel that any enterpriser must consider as completely as possible the impact of his development on the landscape. We have not been able to invent a method whereby the enterpriser can systematically and quantitatively evaluate every impact aspect. Perhaps, then, the major value of considering the impact of a site development on the landscape into which it is set is a processual one. There is a better chance that some congruence between the two will result if the enterpriser can be helped to appreciate and then make an attempt to limit the impact of his actions on the landscape.

Protection of the integrity of all Montana landscapes is an important goal from the point of view of economics, resource stability and biology. Some landscapes, however, are more representative of Montana, past and present, than others. No general systematic procedure for identifying them exists. Therefore, we suggest that the information-gathering potential of the ESPS be utilized to obtain data which could eventually be used to identify these landscapes. When the delimitation of these landscapes which are uniquely reflective of Montana becomes feasible, it might be possible to control the conditions of their development under special legislation.

8.1 Landscape uniqueness

In either case mentioned above, evaluation of the

impact of a development on a landscape or the identification of a uniquely Montana landscape, the task of the enterpriser is difficult. Two portions of the ESPS which might be helpful to him are: the Natural Landscape Quality section (7) and the Degrees of Intrusion Index (5.5). It is conceivable, however, that a landscape which scored only moderately well on the Natural Landscape Quality could be of great significance as a unique Montana landscape. Therefore, the guidelines should not replace a local appreciation of historic or aesthetic value which ranked higher.

The historical significance of the site is the second major area of consideration in this section. In a sense, historic character is similar to landscape uniqueness. A site can have the overall effect of giving a viewing or resident public an opportunity to feel and share the specific historic sense of the place. Examples of areas which might be of historical significance are: older sections of towns (sometimes those most likely to be on the block for urban renewal), old abandoned, or special purpose settlements (ghost towns), isolated homesteads, missions and sites of significant events.

Potential archaeological importance must also be considered in connection with the historical significance of the site. Montana is rich in archaeological sites. Precautions should be taken to insure that development does not destroy anything of archaeological significance. It is strongly recommended that enterprisers undertake an archaeological survey and permit salvage archaeology to be carried out on any site discovered. The most practical means of obtaining qualified opinion is through the State Archaeologist at the University of Montana.

8.2 Rating process

The enterpriser should rate his site on the scale of one to five given below. If historical sites are found, the enterpriser should place them in the appropriate category of importance: local, state or regional, and national. All sources of verification for the rating given the site will be given consideration. The ESPS is constituted so as to make acceptance of feedback concerning this portion of the evaluation an important part of the decision-making process. The publication requirement of the ESPS administrative process is an invitation to comment. If evidence comes to light which conflicts with the enterpriser's rating, action on the permit will be suspended until professional opinions are obtained.

8.3 Rating index

Index numbers:

1. "Landmark" historical feature; some object, location building, etc. which is "one of a kind," a building which is architecturally unique, the first structure in a community, the site of an important battle, an outstanding example of an uncommon occurrence (perhaps a very well-preserved mining town).
2. Multifeatured historical symbols; special purpose towns, stratified archaeological sites, places identified with ethnic histories, past activities, logging towns, historic sections of towns reflecting the town's history.
3. Single feature historical symbols; homesteads, stageway stations, old mills, mission churches.
4. Ephemeral historical feature; some remnants of former occupancy, foundation of a homesteader's cabin, early irrigation channel, old stage road, surface archaeological sites.
5. Historical qualities of the place are unimportant to the neighbors and the community.

If the enterpriser finds that his developmental area ranks three or above on the rating scale, he should notify the local planning board. If the planning board is aware of the historical significance of the site and does not feel that it should be protected, the enterpriser is free to develop the site. If, however, the local planning board believes the site should be protected, it will be necessary for the enterpriser and the local board to reach an accommodation.

- 8.31 Enter rating and comment at 9.831 on the land evaluation sheet.

9.0 Total Land Evaluation Summary

This sheet is to be reproduced in a tear-out form for submission to the agency with the application for an Environmental Site Permit.

9.1 Geogram

Submit the separate form complete with legend to the symbols used to indicate dominance, subdominance and presence.

- 9.254 Land use incompatibility index _____ *
- 9.334 Total disturbance score _____ *
- 9.43 Productivity x disturbance score (_____) _____
- 9.44 Productivity x disturbance alternate (_____) _____
- 9.46 Productivity x disturbance alternate (_____) _____
or
- 9.45 choice of the most accurate method _____ *
- 9.562 Index to site, situation and proposed use change (_____) _____
- 9.57 Total intrusion score (9.562) x (9.334) = _____ *
- 9.625a Degree of site intrusion index (_____) (A)
- 9.625b Degree of immediate impact area
intrusion index (_____) (B)
- 9.63 Predicted degree of intrusion for site (_____) (C)
- 9.631 Difference (A-C) = (_____) _____
- 9.632 Predicted degree of intrusion for
immediate impact area (_____) (D)
- 9.633 Difference (B-D) = (_____) _____
- 9.634 Difference (A-B) = (_____) _____

- 9.641 Alternative 1. Total of
9.631 + 9.633 + 9.634 is less than 1: _____ *
- 9.642 Alternative 2. Sum of 9.631 + 9.633 + 9.634 is
over +6 then enter the square of that result _____ *
- 9.643 Alternative 3. If the sum of
9.631 + 9.633 + 9.634 is between 1 and 6,
use 9.76.
- 9.75 Natural landscape quality score _____ *
- 9.76 Relative natural landscape quality score _____ *
- 9.831 Historical significance rank (_____)

Commentary: _____

- 9.9 The total land evaluation score is obtained by addition of the starred (*) scores. A high score indicates a higher potential for disruption and environmental damage. No precise numerical limits have been placed on the scores for the purpose of permit denial. It should be apparent, however, that any score that is higher than 60% of the possible for any one section should be a sign that the enterprise must seriously consider the search for an alternative location, process, or development design.

10.0 Special Problems

Inevitably, new technology will produce new problems in safe use of the environment. Such developments will simply have to be evaluated according to their characteristics, with the broadest possible interpretation of the public interest and health safety in mind.

With this in mind, a few comments about nuclear power generating plants and the possibilities of geothermal generation follow.

10.1 Points for consideration in planning nuclear power plants

1. Accidents - Montana deserves particularly close scrutiny.

- a) The area has high seismic activity.
- b) Surface and ground water contamination by waste disposal must be carefully prevented. Montana is a headwater state.
- c) Many regions are subject to extreme air trapping by temperature inversions, especially in the western part of the state. Dispersal following an accident could be severely inhibited.

10.12 Exposure from normal operation - Again inversions complicate dispersal. Otherwise, Montana's problems probably coincide with other states'. Since the AEC has been slow in incorporating results of current research into its programs, state planners must keep themselves aware of developments, such as those in biological concentration and general effects on the biosphere. (See 10.16 below.)

10.13 Thermal pollution (also a problem with fossil-fuel plants) - At present the AEC does not even consider thermal pollution in granting permits for nuclear facilities. Montana planners must handle the entire problem alone, again obtaining results of current research, particularly on small lakes and rivers. Montana's thermal pollution problems will be complicated by its cold climate and, again, its temperature inversions. For example, use of evaporative cooling towers to avoid thermal discharge into a lake, say, may lead to increased fogging, icing of roads in winter, etc.

10.14 Nuclear waste transportation and disposal - Montana's climate may increase chances of transportation accidents. At present no disposal facilities are planned for Montana;

someday there may be. Problems of this inevitable consequence of nuclear power are far from solved.

10.15 Transmission lines - Public pressure to build nuclear plants far from cities increases length, and costs, of transmission lines.

10.16 States' rights - Results of the current court case in Minnesota, in which the state is attempting to apply limits on radionuclide emissions stricter than required by the AEC, will be extremely noteworthy to any state which really wants to protect its environment.

10.17 Accidents

a) Consequences - A nuclear reactor cannot explode like a nuclear bomb, but it can release much dangerous radiation in a full-scale accident. The furor seems to arise from the definition of "maximum credible accident" (MCA), which reactor planners are required to consider by the Atomic Energy Commission (AEC). E.g., in a MCA, do all secondary, tertiary, etc. safeguards fail, or just some? As a result there is still a great range of predicted consequences. It has been claimed that the nuclear industry is the only one in which a MCA would be "biologically undetectable," producing perhaps two additional cancer deaths in the U.S. per year. (Compare an often-quoted Brookhaven report in which an MCA was predicted to kill 3400 people outright.) Figures on the order of 1 in 10^5 or 10^6 have been mentioned as the probability of an MCA per reactor per year.

b) Environmental contributions

1) Earthquakes - These are not well enough understood to predict accurately ground displacements at a site. In particular a site on loose fill can experience much greater accelerations than one on bedrock. Seismic considerations are given great weight by the AEC, and were crucial in the abandonment of the reactor at Bodega Head, California, in 1964.

2) Floods - Nuclear plants need cooling water and are hence built close to it. A typical plant cannot take immersion without releasing some radiation. Floods are very difficult to predict (e.g., a flood on Plum Creek, Colorado, exceeded the

highest level of the previous 14 years by a factor of 20). The paucity of data on flooding is impressive.

- 3) Dispersal - Estimating public exposure from a MCA requires meteorological modeling. Such models are reasonably accurate for the terrain for which they have been derived, flat and smooth. It has been pointed out that 60% of the reactor sites now proposed are on coasts or in river valley, regions for which the models are questionable. "Much more work is needed."

10.18 Radiation damage from normal operation - This problem (and that of analyzing accidents, too) is complicated by two factors discussed below, but in general the strong consensus is that nuclear power is the cleanest available (hydro power is clean, but it simply cannot fill the demand; there are few dam sites left). A Swedish study indicates this (reported by its leader, Stig O. Bergstrom).

- a) The power plant is proposed to be located in the center of Stockholm. Both electrical and thermal outputs will be utilized, a revolutionary attempt. However, the project has not been approved; the study is about two years old.

For an electrical output of around 500 MW, it is estimated that the pollutants will amount to:

20 x 10⁶ kg. SO₂/year for an oil-fired plant

10⁶ Curie kr⁸⁷/year for a nuclear-powered plant

The corresponding estimates of damages to humans are expressed in "man-years" lost:

10³ - 10⁵ man-years/year for oil

35 man-years/year for nuclear

- b) Problems complicating estimates of radiation damage

- 1) Biological concentration - The same mechanisms which concentrate pesticides in food chains are at work for radionuclides. In general, using present maximum permissible dose limits (MPD), one finds that food chain concentration is negligible. However, a new development was presented by A. F. Gallegos of Colorado State. Typically the concentration of a radionuclide in water will saturate, the excess depositing in sediments (e.g., there is 2 x 10⁴ as much Pu²³⁴, by weight, in the sea bottom sediments as in the water). Once the water is saturated, the food chain is operating in a world of constant radioactivity

and one would expect today's trout to be no hotter than last year's. But if some part of the chain does interact with the sediment, the activity increases. Gallegos found this to be true for rainbow trout in a Colorado alpine lake. (The nuclide was Cs^{137} , a fallout product, which is still building up.) The complete implications are still speculative.

- 2) Effects of low level exposure - There is **still** debate over the threshold concept, which says that a radiation dose below a certain level is completely harmless ("zero risk"). Current interpretation supports the absence of a threshold, that any exposure produces some risk. The National Committee on Radiation Protection (NCRP) will submit new MPD recommendations to the AEC around 15 December 1970. In their report, which was previewed at the symposium, they will declare the threshold approach "obsolete." Because of this, said Herbert M. Parker, a NCRP member, the MPD is really the "lowest practicable," and that the final choice should be made by the whole society.

This has the ring of the way it should be, for the question of "practicability" is the basic one of values. But, how would the choice be brought to the public?

10.2 Other power sources

Geothermal power may have some small potential in Montana. Although no great area of recent hot vulcanism exists, numerous small hot springs do. The principal problems that arise in the development of such power relate to noise and the need for silencers, as well as hot water disposal. The other is more fundamental and relates to maintenance of long-term yield through the avoidance of rapid pressure or water loss from the heated structure. Some surface waters might conceivably be used for injection.

AEROMETRIC DATA INDEX

"We are in somewhat the same position in regard to polluted air as the fish are with polluted water. We live in it. Accordingly, control is largely a matter of preventing pollutants from escaping from their source, eliminating the source, or of shifting location of the source or the recipient."¹

¹Orris C. Herfindahl and Allen V. Kneese, Quality of the Environment: An Economic Approach to Some Problems in Using Land, Water, and Air, The Johns Hopkins Press, Baltimore, 1965, p. 30.

Nothing in the following system shall be construed to supersede, either directly or through interpretation, standards, rules and regulations in effect now or adopted in the future. The SPS functions, not in lieu of, but in addition to state air pollution statutes and regulations.

Function

The Aerometric Data Index functions as a diagnostic model for the evaluation of the interactions between site and enterprise that are relative to atmospheric quality. In the process of evaluation and scoring, it acts as a guide and a statement of policy.

The basic objectives are: 1) to prevent emission of atmospheric contaminants; 2) to work toward an elimination of presently contributing sources of atmospheric pollution; and 3) to deflect the location of those emission sources considered absolutely unavoidable toward areas which are estimated to have the maximum potential for pollutant dispersal [coupled with] minimum potential hazards to life, public health, and economic well-being.

General Policies

It is clear that control, prevention and prediction of air pollution are aspects of a new, basically complex and still uncertain science. To achieve the level of predictability necessary to assure public health, immensely more accurate and detailed data, ranging from toxicology to meteorology, are needed.

A comprehensive definition of air pollution that would be satisfactory to all elements of society and would remain consistent with biologic fact, logic, and long term human necessities has not been written. If air pollution is described in terms of its effects, the definition may be invalidated over time, since we do not, and will not, know for at least two centuries the magnitude of the consequences. A definition based on presently known specific toxic contents may become an ineffective closed system inconsistent with changes in knowledge or our technological abilities. A definition based on the rates and mechanisms by which the air cleanses itself may well ignore the side effects, frequencies and contexts of occurrence that have proved, or may prove, important to the health of man and other life. Air pollution is perhaps best defined as a process function, "aerial waste disposal."

Degradation beyond present quality levels in local airsheds will be prohibited, independently of limits established under ambient air standards. It is felt that to do otherwise would only encourage the development of uniformly dirty conditions.

It is a well-accepted principle that the "primary factors" to be considered in efforts to minimize air pollution problems by site selection

are the 1) climate and 2) meteorology of the location under consideration.² "However, the acceptance of good air cleaning by any proposed industry or community activity as a first cost of doing business, or of operation, is necessary to prevent a serious air pollution situation from developing."³ It must be recognized that there are no local, national, or state boundaries in the atmosphere. Likewise, each unit of society, from individual to complex community, must share a proportional responsibility for pollution control.

It may eventually be seen that each particular site to be developed must be individually, mathematically modeled to account for local atmospheric uniqueness. Yet, while all this knowledge is building, we will have to make decisions with scant synoptic data. Policies of developmental restraint must prevail. To do otherwise is a reckless and arrogant insult to public health and present knowledge, as well as to the integrity of the biosphere.

This entry in the SPS is not intended to encourage or condone the practice of aerial waste disposal by either dilution or dispersion in any location; rather, the SPS is designed to assess the proportional costs attributable to "atmospheric and related parameters," given particular levels of air cleaning proposed by the enterprise. Indexing and scoring in relation of site to enterprise is intended to show the citizen-enterpriser how to estimate the consequences of his actions and thereby provide him with a rationale for alternative site choice.

Implementation of Objectives

To achieve the objectives stated in the first section, Function, and listed below as 1.0, 2.0, and 3.0, the Site Permit System requires:

1.0--*Prevention of emission of atmospheric contaminants.*

1.1--Full disclosure of information must be made concerning planned and possible emissions by any enterprise.

1.2--This information must be guaranteed by the enterpriser to be accurate within the limits established by the "best state of the art."

1.3--The information should include the volume; timing; type and composition of the future contaminants, including particulate, sulfur oxides, nitrogen oxides, oxidants, hydrocarbons, carbon monoxide, and such other emissions

²J.R. Taylor, A. Hasegawa, and L.A. Chambers, "Control of Air Pollution by Site Selection and Zoning," Air Pollution, World Health Organization, Columbia University Press, 1961, p. 298.

³B.F. Wake, M.E. Soules, L. Champa, and D. Ryan, A Study of Air Pollution in the Flathead Valley, Flathead Co., Montana State Board of Health, Division of Disease Control, 1964, p. 2.

as listed in Appendices I-V; and such other classes of information as are now, or shall in the future be, considered important and relevant by the State Air Pollution Control Board.

1.4--All developing enterprises should measure, adequately describe, and evaluate the meteorological conditions of their chosen site and surroundings. (The potentially useful measurements are not all reasonably available at the present time. [See Appendix VI.] Nevertheless, the minimum data requirements should include those necessary to the site scheme presented in section 3.4.)

1.5--Evidence that local and community planning efforts have not been ignored must be submitted. Written evaluation must be made of other site and situation factors, such as extant ambient air quality. An attempt must be made to evaluate some of the less tangible site qualities such as existing expectations of atmospheric clarity or amenity related to atmospheric conditions such as extant smells, dust problems, etc. so that aesthetic degradation does not occur unknowingly.

2.0--*Insurance that an adequate information base exists upon which public knowledge and competent opinion can be formed.*⁴

2.1--All information specified under 1.1 to 1.5 must be rendered public and must remain available for public inquiry.

2.2--So as to inform a body of local public opinion which may create new pressures for atmospheric sanitation, local enterprise must be responsibly committed to the reduction of ambient levels of atmospheric contamination to acceptable levels before economic growth will be permitted in a polluted area.⁵

⁴It is assumed that an informed public is more capable than an uninformed public of making rational environmental decisions.

⁵The Site Permit System should act to prevent any development which would contribute to an increase in airborne contaminants in the immediate regional airshed, if the records of that region show that the load is up to or above the State Ambient Air Standards for more than 1 percent of the days in any 3 months in a single year. The airshed region may be delimited within watershed divides or be arbitrarily defined as within a ten mile radius around the air sampling instrument, depending on which is smaller. Any governmental unit, city or county, or planning agency may undertake to provide or have ambient air quality data determined.

This would seem to force polluting industries to decentralize, something the system does not willingly contemplate. It should be noted that under general policies there is a non-degradation clause intended to discourage the contamination of the areas which still have relatively clean air. (continued on bottom of next page)

2.3--In order to implement the above, the SPS must notify appropriate governmental units, agencies, and informational media as set forth in the administrative section.

3.0--*Deflection of the emplacement of unavoidably dirty industries or other developments contemplating atmospheric emissions toward the locations in which they will cause the least offense.*

3.1--The potential polluter must be scored according to an indexed estimate of the damage he might cause.

3.2--In order to compare the estimates of potential damage in the context of site and situation, the following factors are used:

- a) Potential for pollutant dispersal (4.11, 4.12, 4.13).
- b) Potential for vegetational damage on site and in the surrounding situation (4.21).
- c) The consequences of proximity and potential exposure of human population (4.31, 4.32, 4.33).
- d) Emission evaluation (4.41, 4.42).

3.3--The evaluation scheme which follows is based on a number of operational conveniences which are occasionally inconsistent with the basic objectives of the Site Permit System. They are a recognition of the probability that no system can prevent all development or completely regulate its magnitude. It is hoped that this system may deflect development to those areas where the consequences of air pollution to individual persons and the public interests will either be diluted or greatly postponed.

3.4--Methods for evaluation may be found in sections 4.1, 4.2, 4.3, and 4.4.

Methods of Evaluation

All meteorologically related testing and observations required in this section are to be made during a three-month period beginning 1 December and ending on 31 February with the average of five consecutive testing periods preceding the date of application to be used where data exist. For areas lacking data or in situations where interpolation of climatic and meteorological data is not applicable, the figures used

⁵(continued) In the interest of minimizing transport and maximizing efficiency of energy utilization as well as that of maintaining environmental and landscape diversity, the Site Permit System should operate in the long run to concentrate development spatially. The notion that a "little pollution is a good thing" is as subversive as the statement that "dilution is the solution" is inane.

will be those representing one testing period as conducted by the enterprise or suitable development agency.⁶

4.1--Potential for Dispersal

4.11--Wind Direction

Wind direction is to be measured by a rapid response wind vane with a low moment of inertia. "The dynamics of the system should be such as to permit the vane to follow, with little or no overshooting, the horizontal turbulent elements which are of such importance in the lateral dispersion of air pollutants."⁷

4.11a--Exposure Time (Table 1)

The evaluation of wind direction consists of determining the percent of time that each quadrant of a grid, centered at the emission point, is downwind from the site. (See Figure 1.)

Figure 1

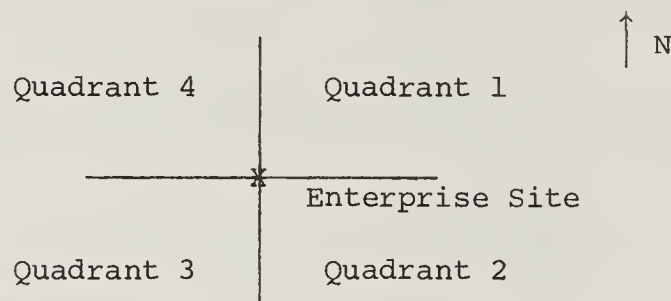


Table 1

Wind Direction Exposure Time	
Location	Percent of Time Downwind
Quadrant 1	
Quadrant 2	
Quadrant 3	
Quadrant 4	

⁶This period coincides roughly with the seasonal classification of winter, recognized by the U.S. Weather Bureau. It was chosen for Montana because of the high probability of stable conditions (Appendix VII) conducive to inversion development and severe local air contaminant concentrations.

⁷E. Wendell Hewson, "Meteorological Measurements," in Arthur C. Stern (ed.), Air Pollution, Vol. II, "Analysis, Monitoring, and Surveying," 2d ed., Academic Press, New York, 1968, p. 341.

The index evaluation of the above information, relating it to population exposure, is made in section 4.31.

4.11b--Standard Deviation of Wind Direction (Table 2)

The standard deviation of horizontal wind direction is required because it influences the diffusion of material emitted into the airshed. If the direction is variable, the potential for turbulence is greater than if not variable, thus an increased diffusion capacity could exist.

Direction determinations, as for those of speed, are to be made at 02, 05, 08, 11, 17, 20, and 23 hundred hours or 2AM, 5AM, 8AM, 11AM, 2PM, 5PM, 8PM, and 11PM respectively, so that they will be consistent with the records of the Environmental Data Service, U.S. Department of Commerce, and to provide for adequate representative random sampling. The directions are those from which the wind blows and for convenience and uniformity are given in tens of degrees, 1 to 36.

Calculation of Standard Deviation of Wind Direction

- | | | |
|----|---|---|
| 1) | $\sum_{i=1}^n X_i$ | Sum the wind direction entries (8 for each day) over the test period. |
| 2) | $\frac{\sum_{i=1}^n X_i}{n}$ | Divide the sum of calculation 1 by the number of entries. This gives the mean wind direction. |
| 3) | $X_i - \bar{X}$ (8 times) | Subtract from each of the measured wind directions (8 per day over the test period) the mean direction derived in Step 2. |
| 4) | $(X_i - \bar{X})^2$ (8 times) | Square each element resulting from Step 3 (8 per day for each day of the test period), i.e., the square of the difference between instantaneous wind direction and mean wind direction. |
| 5) | $\sum_{i=1}^n (X_i - \bar{X})^2$ | Sum the results of Step 4 computations. |
| 6) | $\sqrt{\sum_{i=1}^n (X_i - \bar{X})^2}$ | Take the square root of Step 5. |

7)

Divide Step 6 by the total number of entries for the test period. The result is the standard deviation of wind direction. The higher the standard deviation the greater the turbulence, thus a lower index score, since the index reflects a tendency toward stability.

Table 2

Standard Deviation Wind Direction	Index
From 0° to 10°	10
From 10° to 20°	6
From 20° to 30°	3
From 30° to ∞	1

4.12--Wind Speed

Wind speed is to be measured by a rotation anemometer with a low moment of inertia. The "wind run" or "totalizing cup anemometer" which counts cup assembly rotations rather than instantaneous wind speed is unacceptable.

4.12a--Mean Wind Speed (Table 3)

Although the correlation of night time cloud cover and wind speed with inversion frequency is rather weak, "a trend is evident of observed maximum inversion frequency to occurrence of night time winds less than or equal to 7 miles per hour . . . " ⁸

Said of this same data, applied in Montana, " . . . with an average wind speed of 7.9 miles per hour, a near stagnation condition exists much of the time." ⁹

For evaluation purposes, the mean wind speed of the test period rather than the mean night time wind speed will be used, since the winter test period duplicates in many respects the basic nocturnal stability influencing factor of little solar input.

⁸C.R. Hosler, Low Level Inversion Frequency in the Continuous United States, U.S. Weather Bureau, Washington, D.C., 1961, p. 321.

⁹B.F. Wake, E. Gatzemeier, J. Glenn, M. Swindt, L. Champa, R. Osier, and D. Ryan, A Study of Air Pollution in the Helena-East Helena Area (Helena Valley), October 1965-October 1968, Montana State Board of Health, Division of Air Pollution Control and Industrial Hygiene, Helena, Montana, 1968, p. 8.

Table 3

Mean Wind Speed	Index
From 0 mph to 5 mph	10
From 5 mph to 10 mph	8
From 10 mph to 15 mph	5
From 15 mph to ∞	1

4.12b--Standard Deviation of Wind Speed (Table 4)

The standard deviation of surface wind speed is required because of its influence on the diffusion of material emitted into the airshed. If wind speed is variable (i.e., gusty), the potential for turbulence is greater and an increased dispersal capacity results.

Calculation of Standard Deviation of Wind Speed

- 1) $\sum_{i=1}^n X_i$ Sum the wind speed entries (8 for each day) over the test period.
- 2) $\frac{\sum_{i=1}^n X_i}{n}$ Divide the sum of calculation 1 by the number of entries. This gives the mean wind speed.
- 3) $X_i - \bar{X}$ Subtract from each of the measured wind speeds the mean speed derived in Step 2.
- 4) $(X_i - \bar{X})^2$ Square the differences between instantaneous wind speed and mean wind speed for each of the figures of the Step 3 computation.
- 5) $\sum_{i=1}^n (X_i - \bar{X})^2$ Sum the results of the Step 4 computation.
- 6) $\sqrt{\sum_{i=1}^n (X_i - \bar{X})^2}$ Take the square root of Step 5.
- 7) Divide Step 6 by the total number of entries for the test period. The result is the standard deviation of wind speed. The greater the standard deviation the greater the turbulence, hence a lower index score, since the index is reflective of stability.

Table 4

Standard Deviation Wind Speed	Index
From 0 mph to .5 mph	10
From .5 mph to 1.5 mph	6
From 1.5 mph to 4.5 mph	3
From 4.5 mph to ∞	1

4.13--Topography (Table 5)

"Topography modifies the temperature and wind and their profiles, because of the combined effects of surface friction, radiation, and drainage. The radiative and thermal properties of surface features influence the heating and cooling of the ground surface. Differential heating also causes mountain-valley winds. Upslope and upvalley winds develop in uneven terrain on sunny days when the general air movement is weak. At night, the radiative cooling of the elevated ground leads to downward moving currents owing to differences in air density in the form of downslope and downvalley winds."¹⁰

"A current of air flowing in a direction other than parallel to a valley may suffer channeling, i.e., change of direction toward that of the valley axis."¹¹

"The shielding effects of valley sides may prevent or limit the action of the prevailing regional wind, with resulting lower wind speeds at the surface inside the valley than outside."¹²

An adequate description and model of the influences imposed on the meteorology of a region by its topography perhaps can only be achieved by detailed survey and analysis. Adequate information for such a survey currently does not exist for most situations and the interactions facilitating such analysis are not clear.

It is our contention that, with the evaluation provisions above and the topography definition to follow, a rough but useful picture of the meteorology of a development site and its surrounding situation can be constructed.

¹⁰Hewson, op. cit., p. 203.

¹¹Ibid., p. 204.

¹²Ibid.

Table 5

Topography	Index	Definitions
Closed Mountainous	10	- Closed Mountainous - Lincoln, Superior
Open Mountainous	7	- Open Mountainous - Missoula, Anaconda
Closed Hilly	5	- Closed Hilly - Billings
Open Hills or Breaks	3	- Open Hills or Breaks - Lewistown
Open Flat	1	- Open Flat - Great Falls

4.2--Vegetation Dependence on Air Quality

4.21--Vegetation Composition

"Genetic variability in sensitivity to pollutants is well known and does not necessarily show similar patterns for different pollutants, as evidenced by the inverse susceptibility of some plants to fluoride and sulfur dioxide. Great variability is seen both between species of a given genus and between varieties within a given species."¹³

Although such diverse sensitivities, even among members of a single species, makes the formulation of general classes of susceptibility to damage most difficult, an index based on gross taxonomic categories can be made.

Table 6

Percentage Composition of Total Plant Cover			Index
Evergreens	Deciduous Perennials	Annuals	
66.5 - 100	0 - 33.5	0 - 33.5	10
33.5 - 66.5	33.5 - 66.5	0 - 33.5	8
0 - 33.5	66.5 - 100	33.5 - 66.5	5
0 - 33.5	0 - 33.5	66.5 - 100	1

4.3--Consequence of Proximity and Potential Exposure Period for Human Population

4.31--Exposure Frequency

This evaluation utilizes the wind direction information derived in Table 1 in describing the percent of time that

¹³C. Stafford Brandt and Walter W. Heck, "Effects of Air Pollutants on Vegetation," in Arthur C. Stern (ed.), Air Pollution, Vol. I, "Air Pollution and Its Effects," 2d ed., Academic Press, New York, 1968, p. 419.

the primary¹⁴ and secondary¹⁵ population centers are in the downwind quadrant where they may be subjected to the emissions of the enterprise under evaluation. The greater the period of exposure, the greater the score.

4.31a--Primary Population Center (Table 7)

Table 7

Percent of Time in Downwind Quadrant	Index
More than 50% of the time	10
Between 35% and 50% of the time	7
Between 20% and 35% of the time	4
Less than 20% of the time	1

4.31b--Secondary Population Center (Table 8)

Table 8

Percent of Time in Downwind Quadrant	Index
More than 50% of the time	10
Between 35% and 50% of the time	7
Between 20% and 35% of the time	4
Less than 20% of the time	1

4.32--Average Density of Most Exposed Population (Table 9)

The average density is that of the persons living in the quadrant most frequently downwind of the enterprise and within an arc circumscribed about the enterprise at a distance of 20 miles (i.e., estimated population/area of quadrant; or estimated population/314 sq. mi.).

Table 9

Average Density of Most Exposed Population	Index
Over 1,000 persons/sq. mi.	10
Between 500 and 1,000 persons/sq. mi.	8
Between 100 and 500 persons/sq. mi.	5
Between 0 and 100 persons/sq. mi.	1

¹⁴Primary Population Center means the largest city, town, village or settlement by population within a 25 mile radius of the enterprise site.

¹⁵Secondary Population Center means the second largest city, town, village or settlement by population within a 25 mile radius of the enterprise site.

4.33--Proximity to Enterprise

Proximity to enterprise is a measure of the distance of the primary and secondary population centers to the potential emission sources.

4.33a--Primary Population Center (Table 10)

Table 10

Distance From Emission Sources to Population Center	Index
From 0 to 5 miles	10
From 6 to 12 miles	8
From 13 to 20 miles	5
From 21 to ∞	1

4.33b--Secondary Population Center (Table 11)

Table 11

Distance from Emissions Sources to Population Center	Index
From 0 to 5 miles	10
From 6 to 12 miles	8
From 13 to 20 miles	5
From 21 to ∞	1

4.4--Emission Evaluation

4.41--Pindex¹⁶ (Table 13)

The Pindex Evaluation Scheme which follows is a modification of that proposed by Babcock. In the original, proposed standards for the state of California were used. As applied here, the adopted standards for Montana, where they exist, have been substituted. Where Montana standards do not exist, those chosen by Babcock have been retained.

The evaluation scheme is based on air quality standards and "other generally accepted tenets of air pollution technology."¹⁷ Pindex was designed to facilitate the

¹⁶The explanation of "Pindex" and the example utilizing the scheme have been paraphrased from the paper footnoted below.

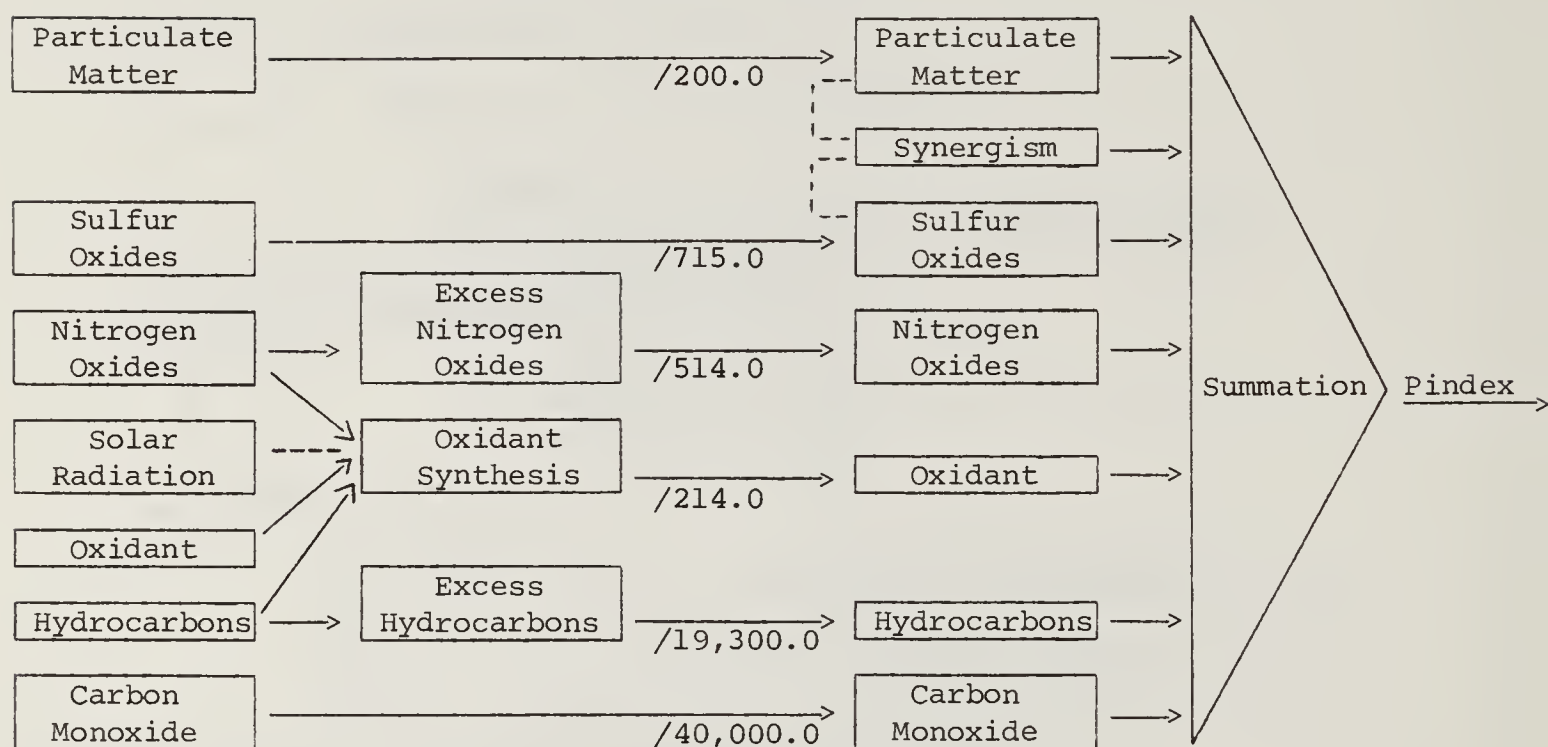
¹⁷Lyndon R. Babcock, Jr., "A Combined Pollution Index for Measurement of Total Air Pollution," Journal of the Air Pollution Control Association, Vol. 20, No. 10, p. 653, October, 1970.

summation of "the contributions of all the major combustion emissions: particulate matter, sulfur oxides, nitrogen oxides, carbon monoxide, and hydrocarbons. In addition, provisions for oxidant as either a primary or secondary pollutant and a term representing particulate matter-sulfur oxides synergism are included."¹⁸ The Pindex method is an attempt to use present knowledge for the assessment of overall air pollution.

The Pindex Evaluation Scheme is schematically illustrated below as Figure 2.

Figure 2

Pindex Evaluation Scheme



The following (Table 12) are the tolerance factors to be applied in the Pindex Evaluation Scheme, an example of which will follow later on.

¹⁸Ibid., p. 655.

Table 12¹⁹

Pollutant	Standard	Tolerance Factor	
		ppm	µg/m ³
Oxidant	<u>0.1 ppm</u> (1 hour California Standard)	0.10	214
Particulate Matter	<u>200 µg/m³</u> (24 hour Montana Standard for total suspended particulate)	-----	200
Nitrogen Oxides	<u>0.25 ppm</u> (1 hour California Standard for nitrogen dioxide)	0.25	514
Sulfur Oxides	<u>0.25 ppm</u> (24 hour Montana Standard for sulfur dioxide)	0.25	715
Hydrocarbons		-----	19,300
Carbon Monoxide	<u>20 ppm</u> (8 hour California Standard)	32.0	40,000

Table 13

Pindex Rating	Index
Over 3.5	10
Between 2.5 and 3.5	7
Between 1.5 and 2.5	4
Less than 1.5	1

4.42--Threshold Limit Values (TLV's) (Tables 14, 15, 16, 17, and 18)

For many of the less understood compounds, indeed for most compounds, needed information defining relationships and interactions does not exist.

In recognition of this informational void, the TLV's established by the American Conference of Governmental Industrial Hygienists are included. We recognize that the TLV limits were designed as in-plant hygiene standards, that the subjects were healthy males, and that they were exposed to the levels of contamination for relatively short durations of time (8 hours per day, 5 days per week). We also recognize

¹⁹See Appendix VIII for basis of tolerance factors.

that the synergistic factors, acknowledged as important in the preceeding evaluation and of accumulation, are not included.

It is our contention that it would be most unfortunate if TLV information were ignored, since it represents, in many cases, the only data available. In spite of these uncertainties, the following method of estimating is consistent and logical.

The enterpriser shall determine, to the best state of the art, the composition of the emissions which would emanate from the proposed activity. A breakdown of total emissions to component compounds is required, with a description of 1) the named compounds, 2) percent composition by weight, and 3) the total daily and average hourly outputs in weights per m³ or ppm.

The TLV of each emission component, as stated in Appendices I, II, III, IV, and V, shall then be given, with the ratio of stack emission concentration to TLV standards being given in percent.

$$\frac{\text{Stack Emission}}{\text{TLV}} \times 100 = \text{stack emission as percent of TLV.}$$

The values derived for each emission by the above equation shall then be summed. The assigned indices are determined in Tables 14 to 18.

Table 14

TLV's for Vapors and Gases	Index
Summed percent of stack emissions/TLV's at or above 100%	10
Summed percent of stack emissions/TLV's between 75% and 100%	7
Summed percent of stack emissions/TLV's between 50% and 75%	4
Summed percent of stack emissions/TLV's less than 50%	1

Table 15

TLV's for Particulates	Index
Summed percent of stack emissions/TLV's at or above 100%	10
Summed percent of stack emissions/TLV's between 75% and 100%	7
Summed percent of stack emissions/TLV's between 50% and 75%	4
Summed percent of stack emissions/TLV's less than 50%	1

Table 16

TLV's for Respirable Dust	Index
Summed percent of stack emissions/TLV's at or above 100%	10
Summed percent of stack emissions/TLV's between 75% and 100%	7
Summed percent of stack emissions/TLV's between 50% and 75%	4
Summed percent of stack emissions/TLV's less than 50%	1

Table 17

Odoriferous Gases	Index
Summed percent of stack emissions/odoriferous gases detectability at or above 100%	10
Summed percent of stack emissions/odoriferous gases detectability between 75% and 100%	7
Summed percent of stack emissions/odoriferous gases detectability between 50% and 75%	4
Summed percent of stack emissions/odoriferous gases detectability less than 50%	1

Table 18

Radionuclide Concentration	Index
Summed percent of stack emissions/allowable radionuclide concentrations at or above 100%	10
Summed percent of stack emissions/allowable radionuclide concentrations between 75% and 100%	7
Summed percent of stack emissions/allowable radionuclide concentrations between 50% and 75%	4
Summed percent of stack emissions/allowable radionuclide concentrations less than 50%	1

EXAMPLE OF AEROMETRIC EVALUATION PROCESS

Description

An enterprise wishes to locate in western Montana. The chosen site is in a narrow confined valley with limited wind movement during long periods of time. The mean wind speed is 5.1 mph with a standard deviation of .2490 mph. The standard deviation of wind direction is 1.6° . It lies 14 miles N45°W of the primary population center and 5 miles S8°W of the secondary population center, thus placing the primary center in Quadrant 2 and the secondary center in Quadrant 1. Both Quadrants 1 and 2 are downwind of the enterprise 36% of the time. The most exposed population is in Quadrant 2 which has a population of 47,100 people.

Upon surveying the area, the vegetation composition is 66.5% evergreens and 33.5% annuals.

The atmospheric emissions of the enterprise would be:

Particulate Matter - $143.0 \mu\text{g}/\text{m}^3$
 Sulfur Oxides - $123.0 \mu\text{g}/\text{m}^3$
 Nitrogen Oxides - $136.0 \mu\text{g}/\text{m}^3$
 Oxidant - $43.2 \mu\text{g}/\text{m}^3$
 Hydrocarbon - $2157.0 \mu\text{g}/\text{m}^3$
 Carbon Monoxide - $7250.0 \mu\text{g}/\text{m}^3$
 Bromine - .009 ppm
 Cadmium Oxide - $.09 \text{ mg}/\text{m}^3$
 Hydrogen Fluoride - $1 \text{ mg}/\text{m}^3$

Scoring4.1--*Potential for Dispersal*

4.11--Wind Direction

4.11a--Exposure Time (See Section 4.31a.)

4.11b--Standard Deviation of Wind Direction The standard deviation of 1.6° results in an assigned index of 10 (from Table 2).

4.12--Wind Speed

4.12a--Mean Wind Speed The mean wind speed of 5.1 mph yields an assigned index of 10 (from Table 3).

4.12b--Standard Deviation of Wind Speed The standard deviation of .2490 mph yields an index of 10 (from Table 4).

4.13--Topography

Since the site is described as being in a narrow confined valley, it has been classified as "closed mountainous" and consequently yields an index of 10 (from Table 5).

4.2--Vegetation Dependence on Air Quality

4.21--Vegetation Composition

With a 66.5% evergreen and a 33.5% annual plant composition, an index of 10 has been assigned (from Table 6).

4.3--Consequence of Proximity and Potential Exposure Period for Human Population

4.31--Exposure Frequency

4.31a--Primary Population Center

The primary population center is in the downwind quadrant of the site location 36% of the time, yielding an index of 7 (from Table 7).

4.31b--Secondary Population Center

The secondary population center is in the downwind quadrant of the site location 36% of the time, yielding an index of 7 (from Table 8).

4.32--Average Density of Most Exposed Population

Since both Quadrants 1 and 2 are most often downwind and are downwind for equal amounts of time, the most densely populated quadrant shall be chosen, that being Quadrant 2. Based on the deliniation of evaluation area in Section 4.32, the population density was determined to be 150 people per square mile, yielding an index score of 5 (from Table 9).

4.33--Proximity to Enterprise

4.33a--Primary Population Center

The primary population center being 14 miles from the source yields an index of 5 (from Table 10).

4.33b--Secondary Population Center

The secondary population center being 5 miles from the source yields an index of 10 (from Table 11).

4.4--Emission Evaluation

4.41--Pindex

-- Convert reactants to $\mu\text{moles}/\text{m}^3$.

Nitrogen Oxides

$$136.0/46.0 = 3.0 \mu\text{moles}/\text{m}^3$$

Hydrocarbon

$$2157.0/16.0 = 134.8 \mu\text{moles}/\text{m}^3$$

Oxidant

$$43.2/48.0 = 0.9 \mu\text{moles}/\text{m}^3$$

- Determine limiting reactant for oxidant synthesis (nitrogen oxide or hydrocarbon).

Nitrogen Oxide is limiting.

- Create Oxidant.

$$\text{Oxidant} = 0.0006 * X \text{ solar radiation}^{**} \\ X \text{ limiting reactant}$$

$$= 0.0006 X 375.0 X 3.0$$

$$= 0.68 \text{ } \mu\text{moles/m}^3$$

- Determine total oxidant and excess hydrocarbon and nitrogen oxide.

$$\text{Oxidant} = 0.9 + 0.68 \\ = 1.6 \text{ } \mu\text{moles/m}^3$$

$$\text{Hydrocarbon} = 134.8 - 0.68 \\ = 134.1 \text{ } \mu\text{moles/m}^3$$

$$\text{Nitrogen Oxide} = 3.0 - 0.68 \\ = 2.3 \text{ } \mu\text{moles/m}^3$$

- Convert reactants back to weight basis.

$$\text{Oxidant} = 1.6 X 48.0 \\ = 76.8 \text{ } \mu\text{g/m}^3$$

$$\text{Hydrocarbon} = 134.1 X 16.0 \\ = 2145.6 \text{ } \mu\text{g/m}^3$$

$$\text{Nitrogen Oxide} = 2.3 X 46.0 \\ = 105.8 \text{ } \mu\text{g/m}^3$$

- Apply tolerance factors.

$$\text{Particulate Matter} = 143.0/200.0 \\ = 0.715$$

$$\text{Sulfur Oxides} = 123.0/715.0 \\ = 0.172$$

$$\text{Nitrogen Oxides} = 105.8/514.0 \\ = 0.210$$

*See Appendix VIII for derivation.

**Solar Radiation is a generalized constant.

$$\begin{aligned}\text{Oxidant} &= 76.8/214.0 \\ &= 0.360\end{aligned}$$

$$\begin{aligned}\text{Hydrocarbon} &= 2145.6/19,300.0 \\ &= 0.111\end{aligned}$$

$$\begin{aligned}\text{Carbon Monoxide} &= 7250.0/40,000.0 \\ &= 0.181\end{aligned}$$

-- Determine synergism term.

Synergism Term = Sulfur Oxides or
Particulate Matter (whichever is
smaller)

$$\begin{aligned}&= \text{Sulfur Oxides} \\ &= 0.172\end{aligned}$$

-- Sum terms to determine Pindex.

$$\begin{aligned}\text{Pindex} &= \text{Particulate Matter (0.715)} \\ &+ \text{Sulfur Oxides (0.172)} \\ &+ \text{Nitrogen Oxides (0.210)} \\ &+ \text{Oxidant (0.360)} \\ &+ \text{Hydrocarbon (0.111)} \\ &+ \text{Carbon Monoxide (0.181)} \\ &+ \text{Synergism Term (0.172)} \\ &= 1.921\end{aligned}$$

A Pindex of 1.921 yields an index
of 4 (from Table 13).

4.42--Threshold Limit Values

-- Gases and Vapors

$$\text{Bromine} = .009/0.1 \times 100 = 9\%$$

$$\text{Total} = 9\%$$

Gases and vapors yield an index of
1 (from Table 14).

-- Particulate Matter

$$\text{Cadmium Oxide} = .09/0.1 \times 100 = 90\%$$

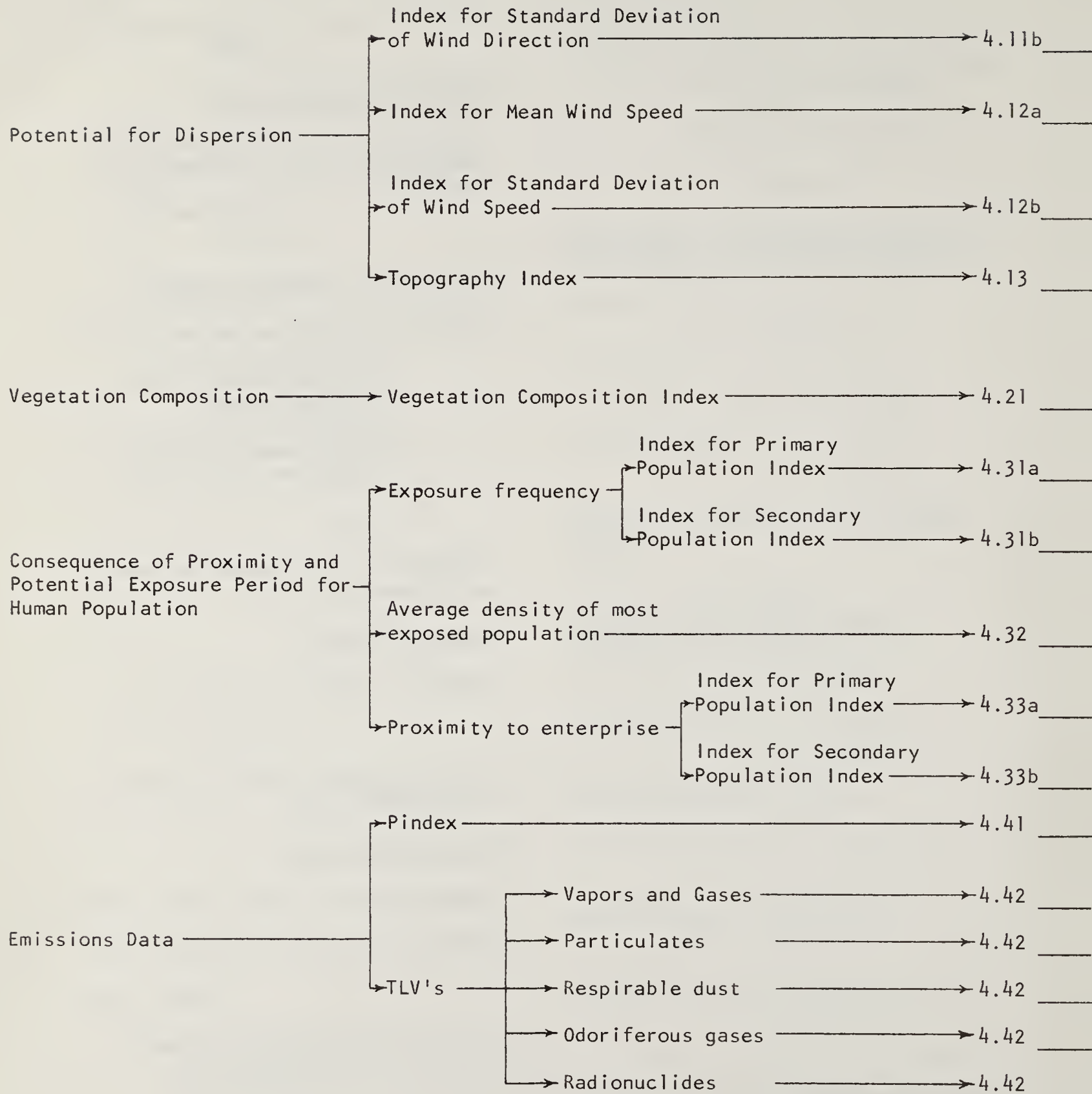
$$\text{Hydrogen Fluoride} = 1/2 \times 100 = 50\%$$

$$\text{Total} = 140\%$$

Particulate matter thus yields an
index of 10 (from Table 15).

TOTAL INDEX SUM = 99

AEROMETRIC DATA FLOWCHART



APPENDIX I*

Index to vapors and gases

TLV based on parts of vapor or
gas per million parts of air
plus vapor by volume at 25°C
and 760 mm. mercury pressure

*based on Figures of the American
Conference of Governmental Industrial
Hygienists

<u>Substance</u>	<u>ppm</u>
Acetaldehyde	200
Acetic acid	10
Acetic anhydride	5
Acetone	1,000
Acetonitrile	40
Acetylene dichloride, see 1, 2 Dichloroethylene	50
Acetylene tetrabromide	1
Acrolein	0.1
Acrylonitrile-skin	20
Allyl alcohol-skin	2
Allyl chloride	1
^c Allyl glycidyl ether (AGE)	10
Allyl propyl disulfide	2
2 Aminoethanol, see Ethanolamine	3
Ammonia	50
n-Amyl acetate	100
Aniline-skin	5
Arsine	0.05
^c Benzene (benzol)-skin	25
p-Benzoquinone, see Quinone	.1
Benzyl chloride	1
^e Biphenyl, see Diphenyl	.2
^c Boron trifluoride	1
Bromine	0.1
Butadiene (1,3-butadiene)	1,000
Butanethiol, see Butyl mercaptan	.0
2-Butanone	200
2-Butoxy ethanol (Butyl Cellosolve)-skin	50
^e Butyl acetate (in-butyl acetate)	150
Butyl alcohol	100
tert. Butyl alcohol	100
^c Butylamine-skin	5
n-Butyl glycidyl ether (BGE)	50
Butyl mercaptan	10
p-tert. Butyltoluene	10
Carbon dioxide	5,000
Carbon disulfide-skin	20
^e Carbon monoxide	50
Carbon tetrachloride-skin	10
^e Chlorine	1
Chlorine dioxide	0.1
^c Chlorine trifluoride	0.1
^c Chloroacetaldehyde	1
Chlorobenzene (mono- chlorobenzene)	75
Chlorobromomethane	200
2-Chloro-1, 3 butadiene, see Chloroprene	25

1, Chloro, 2, 3 epoxypropane, see Epichlorhydrin	5
2, Chloroethanol, see Ethylene chlorohydrin	5
Chloroethylene, see Vinyl chloride	500
^c Chloroform (trichloro- methane)	50
1-Chloro-1-nitropropane	20
Chloropicrin	0.1
Chloroprene (2-chloro-1, 3- butadiene)-skin	25
Cresol (all isomers)-skin	5
^e Cyclohexane	300
Cyclohexanol	50
Cyclohexanone	50
^e Cyclohexene	300
^d Cyclopentadiene	75
Decaborane-skin	0.05
Diacetone alcohol (4-hy- droxy-4-methyl-2-penta- none)	50
1, 2 Diaminoethane, see Ethylenediamine	10
^e 1, 2-Dibromoethane (ethylene dibromide)-skin	25
^c o-Dichlorobenzene	50
p-Dichlorobenzene	75
Dichlorodifluoromethane	1,000
1, 1, -Dichloroethane	100
1, 2-Dichloroethane	50
1, 2-Dichloroethylene	200
^c Dichloroethyl ether-skin	15
Dichloromethane, see Methylenechloride	500
Dichloromonofluoromethane	1,000
^c 1, 1-Dichloro-1-nitroethane	10
1, 2-Dichloropropane, see Propylenedichloride	75
Dichlorotetrafluoroethane	1,000
Diethylamine	25
Diethylether, see Ethyl ether	400
Difluorodibromomethane	100
^c Diglycidyl ether (DGE)	0.5
Diisobutyl ketone	50
Dimethoxymethane, see Methylal	1,000
Dimethyl acetamide-skin	10
^d Dimethylamine	10
Dimethylaminobenzene, see Xylidene	5
Dimethylaniline (N-di- methylaniline)-skin	5
Dimethylbenzene, see Xylene	100

^d Dimethylformamide-skin	10
2, 6 Dimethylheptanone, see Diisobutyl ketone	50
1, 1-Dimethylhydrazine-skin	0.5
Dimethylsulfate-skin	1
Dioxane (Diethylene dioxide)- skin	100
Dipropylene glycol methyl ether-skin	100
Epichlorhydrin-skin	5
1, 2-Epoxypropane, see Propyleneoxide	100
2, 3-Epoxy-1-propanol see Glycidol	50
Ethanethiol, see Ethyl- mercaptan	10
Ethanolamine	3
2 Ethoxyethanol-skin	200
2 Ethoxyethylacetate (Cello- solve acetate)-skin	100
Ethyl acetate	400
Ethyl acrylate-skin	25
Ethyl alcohol (ethanol)	1,000
^e Ethylamine	10
^{c,e} Ethylbenzene	100
Ethyl bromide	200
Ethyl chloride	1,000
Ethyl ether	400
Ethyl formate	100
^{c,e} Ethyl mercaptan	10
Ethyl silicate	100
Ethylene chlorohydrin-skin	5
Ethylenediamine	10
Ethylene dibromide, see 1,2-Dibromoethane	25
Ethylene dichloride, see 1, 2-Dichloroethane	50
^c Ethylene glycol dinitrate- skin	0.2
Ethylene glycol monomethyl ether acetate, see Methyl cellosolve acetate	25
^e Ethylene imine-skin	5
Ethylene oxide	50
Ethylidene chloride, see 1, 1-Dichloroethane	100
Fluorine	0.1
Fluorotrichloromethane	1,000
^c Formaldehyde	5
Freon 11, see Fluorotri- chloromethane	1,000
Freon 12, see Dichlorodi- fluoromethane	1,000
Freon 13B1, see Trifluoro- monobromomethane	1,000
Freon 21, see Dichloromono- fluoromethane	1,000

Freon 112, see 1, 1, 2, 2-Tetrachloro-1, 2 difluoroethane	500
Freon 113, see 1, 1, 2-Tri-chloro, 1, 2, 2-trifluoroethane	1,000
Freon 114, see Dichloro-tetrafluoroethane	1,000
Furfural-skin	5
Furfuryl alcohol	50
Glycidol (2, 3-Epoxy-1-propanol)	50
Glycol monoethyl ether, see 2-Ethoxyethanol	200
Heptane (n-heptane)	500
^d Hexachloroethane-skin	1
Hexane (n-hexane)	500
2-Hexanone	100
Hexone	100
sec-Hexyl acetate	50
Hydrazine-skin	1
Hydrogen bromide	3
^c Hydrogen chloride	5
Hydrogen cyanide-skin	10
Hydrogen fluoride	3
Hydrogen peroxide, 90%	1
Hydrogen selenide	0.05
^d Hydrogen sulfide	10
^c Iodine	0.1
Isoamyl alcohol	100
Isophorone	25
Isopropyl alcohol	400
Isopropylamine	5
Isopropylether	500
Isopropyl glycidyl ether (IGE)	50
Ketene	0.5
^d L.P.G. (Liquified petroleum gas)	1,000
Mesityl oxide	25
Methanethiol, see Methyl mercaptan	10
2-Methoxyethanol, see Methyl cellosolve	25
Methyl acetate	200
Methyl acetylene (propyne)	1,000
^d Methyl acetylene-propadiene mixture (MAPP)	1,000
Methyl acrylate-skin	10
Methylal (dimethoxymethane)	1,000
Methyl alcohol (methanol)	200
Methyl amyl alcohol, see Methyl isobutyl carbinol	25

^C Methyl bromide-skin	20
Methyl butyl ketone, see 2-Hexanone	100
Methyl cellosolve-skin	25
Methyl cellosolve acetate- skin	25
^C Methyl chloride	100
Methyl chloroform	350
Methylcyclohexane	500
Methylcyclohexanol	100
O-Methylcyclohexanone-skin	100
Methyl formate	100
Methyl isobutyl carbinol-skin	25
Methyl isobutyl ketone, see Hexone	100
^{C, d} Methyl mercaptan	10
^d Methyl methacrylate	100
Methyl propyl ketone, see 2-Pentanone	200
^{Ca} Methyl styrene	100
^C Methylene bisphenyl iso- cyanate (MDI)	0.02
Methylene chloride (dichlo- romethane)	500
Monomethyl aniline-skin	2
^d Morpholine-skin	20
Naphtha (coal tar)	200
Naphtha (petroleum)	500
^d Naphthalene	10
Nickel carbonyl	0.001
^d Nitric acid	2
p-Nitroaniline-skin	1
Nitrobenzene-skin	1
Nitroethane	100
^C Nitrogen dioxide	5
^d Nitrogen trifluoride	10
^C Nitroglycerin- + EGDN-skin	0.2
Nitromethane	100
1-Nitropropane	25
2-Nitropropane	25
Nitrotoluene-skin	5
Nitrotrichloromethane, see Chloropicrin	.1
Octane	500
^d Oxygen difluoride	0.05
Ozone	0.1
Pentaborane	0.005
Pentane	1,000
2-Pentanone	200
Perchloroethylene	100
Perchloromethyl mercaptan	0.1
Perchloryl fluoride	3
Phenol-skin	5
Phenyl glycidyl ether (PGE)	50
Phenylhydrazine-skin	5
^d Phosgene (carbonyl chloride)	0.1

Phosphine	0.3
Phosphorus trichloride	0.5
^d Phthalic anhydride	2
^d Propane	1,000
Propyne, see Methyl- acetylene	200
n-Propyl acetate	200
n-Propyl nitrate	25
Propylene dichloride	75
^e Propylene imine-skin	2
Propylene oxide	100
Pyridine	5
Quinone	0.1
Stibine	0.1
Stoddard solvent	500
^c Styrene monomer (phenyl- ethylene)	100
Sulfur dioxide	5
Sulfur hexafluoride	1,000
Sulfur monochloride	1
Sulfur pentafluoride	0.025
Sulfuryl fluoride	5
^d 1, 1, 1, 2-Tetrachloro-2, 2- difluoroethane	500
1, 1, 2, 2-Tetrachloro-1, 2- difluoroethane	500
1, 1, 2, 2-Tetrachloroethane- skin	5
Tetrachloroethylene, see Perchloroethylene	100
Tetrachloromethane, see Carbon tetrachloride	10
Tetrahydrofuran	200
Tetranitromethane	1
Toluene (toluol)	200
^c Toluene-2, 4-diisocyanate	0.02
o-Toluidine-skin	5
1, 1, 1-Trichloroethane; see Methyl chloroform	350
Trichloroethylene	100
Trichloromethane, see Chloroform	50
1, 2, 3-Trichloropropane	50
1, 1, 1-Trichloro 1, 2, 2-tri- fluoroethane	1,000
Triethylamine	25
Trifluoromonobromomethane	1,000
Turpentine	100
Vinyl benzene, see Styrene	100
^c Vinyl chloride	500
Vinylcyanide, see Acrylo- nitrile	20
Vinyl toluene	100
^e Xylene (xylol)	100
Xylidine-skin	5

APPENDIX II*

Index to Particulates

TLV based on milligrams
of particulate per cubic
meter of air

*based on figures of the American
Conference of Governmental Industrial
Hygienists

Substance	mg/m ³
Acetaldehyde	360
Acetic acid	25
Acetic anhydride	20
Acetone	2,400
Acetonitrile	70
Acetylene dichloride, see 1, 2 Dichloroethylene	2-0
Acetylene tetrabromide	14
Acrolein	0.25
Acrylonitrile-skin	45
Aldrin-skin	0.25
Allyl alcohol-skin	5
Allyl chloride	3
^c Allyl glycidyl ether (AGE)	45
Allyl propyl disulfide	12
Ammonia	35
Ammonium sulfamate (Am- mate)	15
n-Amyl acetate	525
Amiline-skin	19
^d Anisidine (o, p-isomers)- skin	0.5
Antimony and compounds (as Sb)	0.5
ANTU (alpha naphthyl thio- urea)	0.3
Arsenic and compounds (as As)	0.5
Arsine	0.5
Barium (soluble compounds)	0.2
^c Benzene (benzol)-skin	80
p-Benzoquinone, see Quinone	.4
^d Benzoyl peroxide	5
Benzyl chloride	5
Beryllium	0.002
^e Biphenyl, see Diphenyl	1
Boron oxide	15
^c Boron trifluoride	3
Bromine	0.7
Butadiene (1, 3-butadiene)	2,200
Butanethiol, see Butyl mercaptan	35
2-Butanone	590
2-Butoxy ethanol (Butyl Cellosolve)-skin	240
^e Butyl acetate (in-butyl acetate)	710
Butyl alcohol	300
tert. Butyl alcohol	300
^c Butylamine-skin	15
^c tert. Butyl chromate (as CrO ₃)-skin	0.1
n-Butyl glycidyl ether (BGE)	270

Butyl mercaptan	35
p-tert. Butyltoluene	60
Cadmium oxide fume	0.1
Calcium arsenate	1
Calcium oxide	5
Camphor	2
^d Carbaryl (Sevin) (R)	5
Carbon dioxide	9,000
Carbon disulfide-skin	60
^e Carbon monoxide	55
Carbon tetrachloride-skin	65
Chlordane-skin	0.5
Chlorinated camphene, -skin	0.5
Chlorinated diphenyl oxide	0.5
^e Chlorine	3
Chlorine dioxide	0.3
^c Chlorine trifluoride	0.4
^c Chloroacetaldehyde	3
Chlorobenzene (mono-chlorobenzene)	350
Chlorobromomethane	1,050
2-Chloro-1, 3 butadiene, see Chloroprene	90
Chlorodiphenyl (42% chlorine)-skin	1
Chlorodiphenyl (54% chlorine)-skin	0.5
1, Chloro, 2, 3 epoxypropane,	19
], Chloroethanol	16
Chloroethylene	1,300
^c Chloroform (trichloromethane)	240
1-Chloro-1-nitropropane	100
Chloropicrin	0.7
Chloroprene (2-chloro-1, 3-butadiene)-skin	90
Chromic acid and chromates (as CrO ₃)	0.1
^e Cobalt	.1
Copper fume	0.1
Dusts and mists	1.0
^d Cotton dust (raw)	1
Crag (R) herbicide	15
Cresol (all isomers)-skin	22
Cyanide (as CN)-skin	5
^e Cyclohexane	1,050
Cyclohexanol	200
Cyclohexanone	200
^e Cyclohexene	1,015
^d Cyclopentadiene	200
2, 4-D	10
DDT-skin	1
DDVP-skin	1
Decaborane-skin	0.3

Demeton (R)-skin	0.1
Diacetone alcohol (4 hydroxy-4-methyl-2-pentanone)	240
1, 2 Diaminoethane, see Ethylenediamine Diborane	25
^e 1, 2-Dibromoethane (ethylene dibromide)-skin	190
^c o-Dichlorobenzene	300
p-Dichlorobenzene	450
Dichlorodifluoromethane	4,950
^d 1, 3-Dichloro-5-dimethyl hydantoin	0.2
1, 1, -Dichloroethane	400
1, 2-Dichloroethane	200
1, 2-Dichloroethylene	790
^c Dichloroethyl ether-skin	90
Dichloromethane, see Methylenechloride	1,740
Dichloromonofluoromethane	4,200
^c 1, 1-Dichloro-1-nitroethane	60
1, 2-Dichloropropane, see Propylenedichloride	350
Dichlorotetrafluoroethane	7,000
Dieldrin-skin	0.25
Diethylamine	75
Diethylether, see Ethyl ether	1,200
Difluorodibromomethane	860
^c Diglycidyl ether (DGE)	2.8
Dihydroxybenzene, see Hydroquinone	2
Diisobutyl ketone	290
Dimethoxymethane, see Methylal	3,100
Dimethyl acetamide-skin	35
^d Dimethylamine	18
Dimethylaminobenzene, see Xylidene	25
Dimethylaniline (N-dimethylaniline)-skin	25
Dimethylbenzene, see Xylene	435
^d Dimethyl 1, 2-dibro-2, 2-dichloroethyl phosphate, (Dibrom) (R)	3
^d Dimethylformamide-skin	30
2, 6 Dimethylheptanone, see Diisobutyl ketone	290
1, 1-Dimethylhydrazine-skin	1
Dimethylsulfate-skin	5
Dinitrobenzene (all isomers)-skin	1
Dinitro-o-cresol-skin	0.2
Dinitrotoluene-skin	1.5
Dioxane (Diethylene dioxide)-skin	360
Dipropylene glycol methyl ether-skin	600

^d Di-sec, octyl phthalate (Di- 2-ethylhexylphthalate	5
Endrin-skin	0.1
Epichlorhydrin-skin	19
EPN-skin	0.5
1, 2-Epoxypropane, see Propyleneoxide	240
2, 3-Epoxy-1-propanol see Glycidol	150
Ethanethiol, see Ethyl- mercaptan	25
Ethanolamine	6
2 Ethoxyethanol-skin	740
2 Ethoxyethylacetate (Cello- solve acetate)-skin	540
Ethyl acetate	1,400
Ethyl acrylate-skin	100
Ethyl alcohol (ethanol)	1,900
^e Ethylamine	18
^{c,e} Ethylbenzene	435
Ethyl bromide	890
Ethyl chloride	2,600
Ethyl ether	1,200
Ethyl formate	300
^{c,e} Ethyl mercaptan	25
Ethyl silicate	850
Ethylene chlorohydrin-skin	16
Ethylenediamine	25
Ethylene dibromide, see 1, 2-Dibromoethane	190
Ethylene dichloride, see 1, 2-Dichloroethane	200
^c Ethylene glycol dinitrate- skin	1.2
Ethylene glycol monomethyl ether acetate, see Methyl cellosolve acetate	120
^e Ethylene imine-skin	.1
Ethylene oxide	90
Ethylidene chloride, see 1, 1-Dichloroethane	400
Ferbam	15
Ferrovandium dust	1
Fluoride (as F)	2.5
Fluorine	0.2
Fluorotrichloromethane	5,600
^c Formaldehyde	6
Freon 11, see Fluorotri- chloromethane	5,600
Freon 12, see Dichlorodi- fluoromethane	4,950
Freon 13B1, see Trifluoro- monobromomethane	6,100
Freon 21, see Dichloromono- fluoromethane	4,200

Freon 112, see 1, 1, 2, 2-Tetrachloro-1, 2 difluoroethane	4,170
Freon 113, see 1, 1, 2-Tri-chloro, 1, 2, 2-trifluoroethane	7,600
Freon 114, see Dichloro-tetrafluoroethane	7,000
Furfural-skin	20
Furfuryl alcohol	200
Glycidol (2, 3-Epoxy-1-propanol)	150
Glycol monoethyl ether, see 2-Ethoxyethanol	740
^e Guthion, see Azinphosmethyl	.2
Hafnium	0.5
Heptachlor-skin	0.5
Heptane (n-heptane)	2,000
^d Hexachloroethane-skin	10
Hexane (n-hexane)	1,800
2-Hexanone	410
Hexone	410
sec-Hexyl acetate	295
Hydrazine-skin	1.3
Hydrogen bromide	10
^c Hydrogen chloride	7
Hydrogen cyanide-skin	11
Hydrogen fluoride	2
Hydrogen peroxide, 90%	1.4
Hydrogen selenide	0.2
^d Hydrogen sulfide	15
Hydroquinone	2
^c Iodine	1
^e Iron oxide fume	10
Isoamyl alcohol	360
Isophorone	140
Isopropyl alcohol	980
Isopropylamine	12
Isopropylether	2,100
Isopropyl glycidyl ether (IGE)	240
Ketene	0.9
Lead	0.2
Lead arsenate	0.15
Lindane-skin	0.5
Lithium hydride	0.025
^d L.P.G. (Liquified petroleum gas)	1,800
Magnesium oxide fume	15
Malathion-skin	15
^c Manganese	5
Mercury-skin	0.1
Mercury (organic compounds)-skin	0.01

Mesityl oxide	100
Methanethiol, see Methyl mercaptan	20
Methoxychlor	15
2-Methoxyethanol, see Methyl cellosolve	80
Methyl acetate	610
Methyl acetylene (propyne)	1,650
^d Methyl acetylene-propadiene mixture (MAPP)	1,800
Methyl acrylate-skin	35
Methylal (dimethoxymethane)	3,100
Methyl alcohol (methanol)	260
Methyl amyl alcohol	100
^c Methyl bromide-skin	80
Methyl butyl ketone	410
Methyl cellosolve-skin	80
Methyl cellosolve acetate-skin	120
^c Methyl chloride	210
Methyl chloroform	1,900
Methylcyclohexane	2,000
Methylcyclohexanol	470
o-Methylcyclohexanone-skin	460
Methyl formate	250
Methyl isobutyl carbinol-skin	100
Methyl isobutyl ketone	410
^{c,d} Methyl mercaptan	20
^d Methyl methacrylate	410
Methyl propyl ketone	700
^{ca} Methyl styrene	480
^c Methylene bisphenyl isocyanate (MDI)	0.2
Methylene chloride (dichloromethane)	1,740
Molybdenum (soluble compounds)	5
(insoluble compounds)	15
Monomethyl aniline-skin	9
^d Morpholine-skin	70
Naphtha (coal tar)	800
Naphtha (petroleum)	2,000
^d Naphthalene	50
Nickel carbonyl	0.007
^d Nickel, metal and soluble compounds	1
Nicotine-skin	0.5
^d Nitric acid	5
p-Nitroaniline-skin	6
Nitrobenzene-skin	5
^d p-Nitrochloro-benzene-skin	1
Nitroethane	310
^c Nitrogen dioxide	9
^d Nitrogen trifluoride	29
^c Nitroglycerin- +EGDN-skin	2

Nitromethane	
1-Nitropropane	250
2-Nitropropane	90
Nitrotoluene-skin	90
Nitrotrichloromethane, see Chloropicrin	30
Octane	.7
Oil mist (mineral)	2,350
Osmium tetroxide	5
^d Oxygen difluoride	0.002
Ozone	0.1
Parathion-skin	0.2
Pentaborane	0.1
Pentachloronaphthalene-skin	0.01
Pentachlorophenol-skin	0.5
Pentane	0.5
2-Pentanone	2,950
Perchloroethylene	700
Perchloromethyl mercaptan	670
Perchloryl fluoride	0.8
Phenol-skin	13.5
^d p-Phenylene diamine-skin	19
Phenyl glycidyl ether (PGE)	0.1
Phenylhydrazine-skin	310
Phosdrin (Mevinphos) (R)- skin	22
^d Phosgene (carbonyl chloride)	0.1
Phosphine	0.4
Phosphoric acid	0.4
Phosphorus (yellow)	1
Phosphorus pentachloride	0.1
Phosphorus pentasulfide	1
Phosphorus trichloride	1
^d Phthalic anhydride	3
Picric acid-skin	12
Platinum (Soluble salts)	0.1
^d Propane	0.002
Propyne, see Methyl- acetylene	1,800
n-Propyl acetate	610
n-Propyl nitrate	840
Propylene dichloride	110
^e Propylene imine-skin	350
Propylene oxide	5
Pyrethrum	240
Pyridine	5
Quinone	15
Rotenone (commercial)	0.4
^d Selenium compounds (as Se)	5
^d Silver, metal and soluble compounds	0.2
Sodium fluoroacetate (1080) - skin	0.01
Sodium hydroxide	0.05
	2

Stibine	0.5
Stoddard solvent	2,900
Strychnine	0.15
^c Styrene monomer (phenyl-ethylene)	420
Sulfur dioxide	13
Sulfur hexafluoride	6,000
Sulfuric acid	1
Sulfur monochloride	6
Sulfur pentafluoride	0.25
Sulfuryl fluoride	20
Systox, see Demeton	.1
2, 4, 5 T	10
Tantalum	5
TEDP - skin	0.2
Tellurium	0.1
TEPP - skin	0.05
^d 1, 1, 1, 2-Tetrachloro-2, 2-difluoroethane	4,170
1, 1, 2, 2-Tetrachloro-1, 2-difluoroethane	4,170
1, 1, 2, 2-Tetrachloroethane-skin	35
Tetrachloroethylene, see Perchloroethylene	670
Tetrachloromethane, see Carbon tetrachloride	65
Tetraethyl lead (as Pb)-skin	0.075
Tetrahydrofuran	590
Tetranitromethane	8
Tetryl (2, 4, 6-trinitrophenyl-methylnitramine)-skin	1.5
Thallium (soluble compounds)-skin	0.1
Thiram	5
Tin (inorganic compounds, except oxide)	2
Tin (organic compounds)	0.1
Titanium dioxide	15
Toluene (toluol)	750
^c Toluene-2, 4-diisocyanate	0.14
o-Toluidine-skin	22
Toxaphene, see Chlorinated camphene	.5
1, 1, 1-Trichloroethane, see Methyl chloroform	1,900
Trichloroethylene	535
Trichloromethane, see Chloroform	240
Trichloronaphthalene-skin	5
1, 2, 3-Trichloropropane	300
1, 1, 2-Trichloro 1, 2, 2-trifluoroethane	7,600
Triethylamine	100
Trifluoromonobromomethane	6,100
2, 4, 6-Trinitrophenol see Picric acid	.1

2, 4, 6-Trinitrophenylmethyl- nitramine, see Tetryl	1.6
Trinitrotoluene-skin	1.5
Triorthocresyl phosphate	0.1
Triphenyl phosphate	3
Turpentine	560
Uranium (soluble compounds)	0.05
(insoluble compounds)	0.25
^c Vanadium (V ₂ O ₅ dust)	0.5
(V ₂ O ₅ fume)	0.1
Vinyl benzene, see Styrene	240
^c Vinyl chloride	1,300
Vinylcyanide, see Acrylo- nitrile	45
Vinyl toluene	480
Warfarin	0.1
^e Xylene (xylol)	435
Xylidine-skin	25
^d Yttrium	1
Zinc oxide fume	5
Zirconium compounds (as Zr)	5

APPENDIX III*

TLV for Respirable Dust
Millions of particles per
cubic foot of air

*based on figures of the American
Conference of Governmental Industrial
Hygienists

Respirable Dusts Evaluated by Count

Substance	mp/ft ^{3a}	Substance	mp/ft ^{3a}
Silica		Talc	20
Crystalline		Portland Cement	50
Quartz, threshold limit	250 ^b	Miscellaneous (less than 1%	
calculated from the	<u>%SiO₂ + 5</u>	crystalline silica) ^d	50
formula		Graphite (natural)	
Cristobalite formula		"Inert" or Nuisance Par-	
calculated	"	ticulates	50 (or 15 mg/m ³ which-
Amorphous, including		see Appendix D	ever is the smaller)
natural diatomaceous			
earth	20	Conversion factors	
Silicates (less than 1%		mppcf x 35.3 = million particles per cubic	
crystalline silica)		meter	
Asbestos	5	= particles per c.c.	
Mica	20		
Soapstone	20		

^bThe percentage of crystalline silica in the formula is the amount determined from air-borne samples, except in those instances in which other methods have been shown to be applicable.

APPENDIX IV*

Index of Odoriferous Gases

Manufacturing Chemists Association

(1968)

*based on figures of the Manufacturing
Chemists Association, 1968

<u>Substance</u>	<u>ppm</u>
Acetaldehyde	0.21
Acetic acid	1.0
Acetone	100.0
Acrolein	0.21
Acrylonitrile	21.4
Allyl chloride	0.47
Amine, dimethyl	0.047
Amine, monomethyl	0.021
Amine, trimethyl	0.00021
Ammonia	46.8
Aniline	1.0
Benzene	4.68
Benzyl chloride	0.047
Benzyl sulfide	0.0021
Bromine	0.047
Butyric acid	0.001
Carbon disulfide	0.21
Carbon tetrachloride (chlorination of CS ₂)	21.4
Carbon tetrachloride (Chlorination of CH ₄)	100.0
Chloral	0.047
Chlorine	0.314
Dimeth-lacetamide	46.8
Dimethylformamide	100.0
Dimethyl sulfide	0.001
Diphenyl ether (perfume grade)	0.1
Diphenyl sulfide	0.0047
Ethanol (synthetic)	10.0
Ethyl acrylate	0.00047
Ethyl mercaptan	0.001
Formaldehyde	1.0
Hydrochloric acid gas	10.0
Methanol	100.0
Methyl chlorid	above 10 ppm
Methylene chloride	214.0
Methyl ethyl ketone	10.0
Methyl isobutyl ketone	0.47
Methyl mercaptan	0.0021
Methyl methacrylate	0.21
Monochlorobenzene	0.21
Nitrobenzene	0.0047
Paracresol	0.001
Paraxylene	0.47
Perchloroethylene	4.68
Phenol	0.047
Phosgene	1.0
Phosphine	0.021

Pyridine	0.021
Styrene (inhibited)	0.1
Styrene (uninhibited)	0.047
Sulfur dichloride	0.001
Sulfur dioxide	0.47
Toluene (from coke)	4.68
Toluene (from petroleum)	2.14
Tolylene diisocyanate	2.14
Trichloroethylene	21.4

APPENDIX V

Index of Maximum Permissible
Radionuclide Concentrations in
the Air.

*Figures based on U.S. Department of
Commerce, National Bureau of Standards,
Handbook 69

Radionuclide	Maximum permissible concentrations for 168 hour week nc/cc <u>total body exposure</u>
Actinium	
Ac ²²⁷	.000000000003
Ac ²²⁸	.00000005
Americium	
Am ²⁴¹	.000000000005
Am ²⁴³	.000000000005
Antimony	
Sb ¹²²	.00001
Sb ¹²⁴	.00000007
Sb ¹²⁶	.0000002
Argon	
Ar ⁴¹	.0000004
Arsenic	
As ⁷³	.0000007
As ⁷⁴	0000003
As ⁷⁶	000002
As ⁷⁷	.000007
Astatine	
At ²¹¹	.00000004
Sarium	
Ba ¹³¹	.0000007
Ba ¹⁴⁰	.000001
Berkelium	
Bk ²⁴⁹	.000000002
Beryllium	
Be ⁷	.000002
Bismuth	
Bi ²⁰⁶	.0000005
Bi ²⁰⁷	.0000005
Bi ²¹⁰	.000001
Bi ²¹²	.0000008
Bromine	
Br ⁸²	.0000004
Cadmium	
Cd ¹⁰⁹	.0000002
Cd ^{115m}	.000001
Cd ¹¹⁵	.000002
Calcium	
Ca ⁴⁵	.00000009
Ca ⁴⁷	.0000002
Californium	
Cf ²⁴⁹	.000000000004
Cf ²⁵⁰	.0000000001
Cf ²⁵²	.00000000005
Carbon	
C ¹⁴ CO ₂	.000002
Cerium	
Ce ¹⁴¹	.0000004
Ce ¹⁴²	-----
Ce ¹⁴³	.000002
Ce ¹⁴⁴	.0000001

Cesium	
Cs131	.000004
Cs134m	.00004
Cs134	.0000001
Cs135	.0000002
Cs136	.000001
Cs137	.00000002
Chlorine	
Cl36	.0000010
Cl38	.00002
Chromium	
Cr51	.000004
Cobalt	
Co57	.000002
Co58m	.00005
Co58	.0000003
Co60	.000001
Copper	
Cu64	.0001
Curium	
Cm242	.0000000002
Cm243	.000000000007
Cm244	.000000000009
Cm245	.000000000005
Cm246	.000000000005
Dysprosium	
Dy165	.00006
Dy166	.00001
Erbium	
Er169	.0000008
Er171	.0001
Europium	
Eu152 (9.2 hr.)	.000008
Eu152 (13 yr.)	.000000007
Eu154	.000000004
Eu155	.00000005
Fluorine	
F18	.00010
Gadolinium	
Gd153	.000001
Gd159	.0001
Gallium	
Ga72	.000003
Ga71	.0003
Gold	
Au196	.0000009
Au198	.000002
Au199	.000004
Hafnium	
Hf181	.000001
Hydrogen	
H3 (H ³ O)	.000007
Holmium	
Ho166	.0000004

Indium	
In ^{113m}	
In ^{114m}	.001
In ^{115m}	.000001
In ¹¹⁵	.000006
Iodine	.0000003
I ¹²⁶	
I ¹²⁹	
I ¹³¹	.0000003
I ¹³²	.00000007
I ¹³³	.0000003
I ¹³⁴	.000006
I ¹³⁵	.00001
Iridium	.00002
Ir ¹⁹⁰	.000003
Ir ¹⁹²	
Ir ¹⁹⁴	.0000008
Iron	.000001
Fe ⁵⁵	.000004
Fe ⁵⁹	
Krypton	.0000008
Kr ^{85m}	.00000007
Kr ⁸⁵	
Kr ⁸⁷	.00001
Lanthanum	.000003
La ¹⁴⁰	.0000002
Lead	
Pb ²⁰³	.0000009
Pb ²¹⁰	
Pb ²¹²	.000005
Lutetium	.0000000004
Lu ¹⁷⁷	.00000006
Manganese	
Mn ⁵²	.000002
Mn ⁵⁴	
Mn ⁵⁶	.0000003
Mercury	.0000003
Hg ^{197m}	.0001
Hg ¹⁹⁷	
Hg ²⁰³	.000004
Molybdenum	.000005
Mo ⁹³	.0000005
Mo ⁹⁹	
Neodymium	-----
Nd ¹⁴⁴	.00001
Nd ¹⁴⁷	
Nd ¹⁴⁹	.0000000002
Neptunium	.0000006
Np ²³⁷	.00003
Np ²³⁹	
Nickel	.000000000006
Ni ⁵⁹	.000004
Ni ⁶³	
Ni ⁶⁵	.0000003
	.000001
	.0001

Niobium	
Nb93m	.000001
Nb95	.0000002
Nb97	.00006
Osmium	
Os185	.000002
Os191m	.00008
Os191	.000008
Os193	.000007
Palladium	
Pd103	.000008
Pd107	-----
Pd109	.000009
Phosphorus	
p32	.0000010
Platinum	
Pt191	.00001
Pt193m	.0001
Pt193	.000002
Pt197m	.00007
Pt197	.0001
Plutonium	
Pu238	.000000000005
Pu239	.000000000005
Pu240	.000000000005
Pu241	.0000000003
Pu242	.000000000005
Polonium	
Po210	.000000002
Potassium	
K40	-----
K42	.00001
Praseodymium	
Pr142	.000004
Pr143	.0000006
Pr144	-----
Promethium	
Pm147	.000001
Pm149	.000002
Protactinium	
Pa230	.000000003
Pa231	.000000000002
Pa233	.0000003
Radium	
Ra222	-----
Ra223	.00000001
Ra224	.000000003
Ra226	.000000000002
Ra228	.00000000003
Rhenium	
Re183	.0000009
Re186	.00001
Re187	.00002
Re188	.000002

Rhodium	
Rh103m	.01
Rh105	.000007
Rubidium	
Rb85	-----
Rb86	.000001
Rb87	.0000002
Ruthenium	
Ru97	.000009
Ru103	.0000009
Ru105	.0001
Ru106	.0000003
Samarium	
Sm147	.0000000002
Sm151	.000001
Sm153	.000005
Scandium	
Sc46	.000001
Sc47	.000003
Sc48	.0000007
Selenium	
Se75	.0000005
Silicon	
Si31	.00002
Silver	
Ag105	.00001
Ag110m	.0000003
Ag111	.000002
Sodium	
Na22	.00000006
Na24	.0000006
Strontium	
Sr85m	.00008
Sr85	.00000008
Sr89	.00000006
Sr90	.0000000003
Sr91	.000002
Sr92	.000006
Sulfur	
S35	.0000004
Tantalum	
Ta182	.00000003
Technetium	
Tc96m	.001
Tc96	.00001
Tc97m	.00002
Tc97	.00007
Tc99m	.00009
Tc99	.0001
Tellurium	
Te125m	.00001
Te127m	.0000004
Te127	.00002
Te129m	.0000002
Te129	.00004
Te131m	.000006
Te132	.0000004

Terbium	
Tb ¹⁶⁰	.00000005
Thalium	
Tm ¹⁷⁰	.00000007
Tm ¹⁷¹	.00000003
Thallium	
Tl ²⁰⁰	.0000004
Tl ²⁰¹	.0000004
Tl ²⁰²	.000001
Tl ²⁰⁴	.000001
Thorium	
Th ²²⁷	.0000000007
Th ²²⁸	.00000000002
Th ²³⁰	.000000000005
Th ²³¹	.0001
Th ²³²	.000000000004
Th ²³⁴	.000001
Th-nat.	.000000000003
Tin	
Sn ¹¹³	.00000003
Sn ¹²⁵	.00000004
Tungsten	
W ¹³⁸	-----
W ¹⁸¹	.0001
W ¹⁸⁵	.00002
W ¹⁸⁷	.000007
Uranium	
U ²³⁰	.0000000005
U ²³²	.0000000001
U ²³³	.0000000005
U ²³⁴	.0000000006
U ²³⁵	.0000000006
U ²³⁶	.0000000006
U ²³⁸	.0000000006
U nat.	.0000000003
Vanadium	
V ⁴⁸	.000001
Xenon	
Xe ^{131m}	.000004
Xe ¹³³	.000003
Xe ¹³⁵	.00001
Ytterbium	
Yb ¹⁷⁵	.000004
Yttrium	
Y ⁹⁰	.00001
Y ^{91m}	.00008
Y ⁹¹	.00000008
Y ⁹²	.0001
Y ⁹³	.000004
Zinc	
Zn ⁶⁵	.00000004
Zn ^{69m}	.000006
Zn ⁶⁹	.0002
Zirconium	
Zr ⁹³	.0000003
Zr ⁹⁵	.00000004
Zr ⁹⁷	.000002

APPENDIX VI*

Atmospheric and Related Parameters

*based on Storage and Retrieval of
Aerometric Data, A Parameter Coding
Manual, EPA, 1970

Atmospheric and Related Parameters

Ventilation Diffusion

Wind...speed, direction, resultant speed, resultant direction, average speed, standard deviation of horizontal wind direction, standard deviation of vertical wind direction, standard deviation of wind speed

Inversion...height, lapse rate, stability

Temperature, Humidity, Degree Days

Temperature...dry-bulb, wet-bulb, dew point (24 hour minimum), (24 hour maximum)

Humidity...relative humidity, absolute humidity, mixing ratio

Degree Days...heating degree days, cooling degree days

Visibility, Solar Radiation

Visibility

Light Transmission...turbidity

Solar Radiation...intensity, ultraviolet radiation, infrared radiation, sunshine

Atmospheric Pressure

Barometric Pressure...station pressure, sea level pressure

Vapor Pressure...water vapor pressure

Precipitation

Precipitation...rain or melted precipitation (24 hour total), rain or melted precipitation (observed period total), snow fall (24 hour total), snow fall (observed period total)

Ground Cover...snow depth

Composition...Volume, pH, conductivity, solids content, radioactivity, strong acid, weak acid, strong base, weak base, lithium, sodium, potassium, magnesium, calcium, fluoride, chloride, bromide, ammonium, carbonate, bicarbonate, nitrate, sulfate, bisulfate, formate, acetate, phosphate-tribasic, phosphate-dibasic, phosphate-monobasic

Weather Conditions

Sky Conditions...current conditions (all layers), average conditions (6AM to 6PM), 24 hour average conditions, first layer clouds, height of first layer, second layer clouds, height of second layer clouds, third layer clouds, height of third layer clouds.

Surface Conditions...ground

Weather Conditions...precipitation occurring, visibility restriction

Electrical Phenomena

Ion Density...large + ions, large - ions, small + ions, small - ions

Potential gradient -

The above parameters were designed for local agencies establishing new computerized air monitoring systems and allow for the orderly storage and retrieval of air quality related data. Many of these parameters, however, represent interactional elements that we do not fully understand, and necessitate raw data inputs far in excess of those commonly available in Montana at the present time. Many of these parameters also function only instantaneously, modeling the interactions occurring at a given point in time.

In contrast, the Site Permit System parameters must 1) model the interactions occurring over a period of time thus evaluating the average interaction and not the instantaneous extreme, and 2) must represent the most sensitive indicators of climatologic and meteorologic character and quality while considering currently available data and the cost of new state wide data generation. It would be hoped, however, that as experience and needed resources are obtained, a more thorough and comprehensive approach toward aerometric evaluation would be adopted and integrated into the Site Permit System, allowing for the construction of instantaneously accurate models which could then be evaluated over time, with the resultant model being constructed from real sets of conditions rather than from sets of generalized conditions.

APPENDIX VII

Inversion Duration Data

Inversion Duration Data from Stations of Montana, Idaho, Wyoming, North Dakota,
and South Dakota

Station	Season	Inversion (% of total time)
Montana		
Great Falls	Winter	48
	Spring	31
	Summer	28
	Fall	38
Glasgow	Winter	48
	Spring	33
	Summer	32
	Fall	44
Idaho		
Boise	Winter	51
	Spring	38
	Summer	36
	Fall	51
Wyoming		
Lander	Winter	57
	Spring	31
	Summer	33
	Fall	46
North Dakota		
Bismark	Winter	42
	Spring	28
	Summer	29
	Fall	37
South Dakota		
Rapid City	Winter	48
	Spring	30
	Summer	29
	Fall	42

.....

As illustrated above, the Winter inversion period is greater than that of Fall by an average of 5.5%, of Spring by 17.16% and of Summer by 17.82%, substantiating our testing period choice.

HYDROLOGIC DATA INDEX

"In water, life began; in water it evolved,
until life on land is integral, essential
to the water cycle.
Now water, rising under the sun as vapor,
forming clouds, drifting as mist, cooled by
night into dew and frost,
falling as rain, sleet, snow,
drips into forests and grasses and is breathed
back by them into the air
sinks through soil held firm by roots to fill
the dark lakes underground,
or sparkling forth as springs to flow in
streams and rivers back into the sea."¹

¹Ansel Adams and Nancy Newhall, This is the American Earth, Sierra Club-Ballantine Books, New York, 1960, p. 73.

The following system functions not in lieu of, but rather in addition to present policies, rules, regulations and standards adopted in response to statutory requirements of the current water related laws of the State of Montana.

Function

The Hydrologic Data Index functions as a diagnostic model for the evaluation of interactions between site and enterprise relative to water quality and hydrologic function. It acts as a guide and a statement of policy.

Basic objectives are: 1) to prevent the contamination or alteration in physical property of water as a result of its utilization by either an enterprise or community activity; 2) to work to eliminate present sources contributing to the contamination or alteration in physical property of water; 3) to prevent the mining of water; 4) to provide for a program of recharge in those areas undergoing or that have undergone mining of their water supplies; and 5) to deflect the location of those enterprises or community activities (whose water-borne wastes are considered absolutely unavoidable or inevitable) toward sites, the use of which will least affect (not necessarily least noticed) water quality, supply or flow for the purposes of minimizing the potential hazards to life, public health, and economic well-being.

General Policies

The identification and quantification of wastes dumped into the hydrosphere and the paths of interaction--decay, dilution, or accumulation--to follow, are at best poorly understood and at worst completely ignored in the planning process. The lack of systems information has been painfully clear as we have surveyed the research available. The frustration of pursuing dead-end or woefully incomplete research has left us upon occasion with the feeling that to attempt the indexing of any of the parameters included herein, is so inadequate as to be absurd. Yet to not act and to ignore the information available is a crime against all life. In the words of an often quoted cartoon, 'If you are not part of the solution, you are part of the problem.'

"Since a complete description of ecological effects on regional ecological systems may be decades in coming, selective guidance from incomplete information will have to be used."²

The parameters and indices included in the hydrologic data evaluation recognize a general deterioration in water quality and a rapid increase in its demand. They also recognize that, barring any major climatic or geologic change, the average amount of available fresh water will not increase but will perhaps even be decreasing as consumptive uses increase.

²Leonard L. Ciaccio, Water and Water Pollution Handbook, Vol. 1, Marcel deffer, Inc., New York, 1971, p. iv.

The additional reservoirs being built will increase losses due to evaporation. It is felt that the programs attempting to increase the available supply (cloud seeding, evaporation suppression, and desalinization) will only be marginally effective, resulting in no appreciable increase in supply. Perhaps they will contribute greatly to the further deterioration of water quality.

President Kennedy, in his Message to Congress on February 23, 1961, said,

"Pollution of our country's rivers and streams has, as a result of our rapid population and industrial growth and change, reached alarming proportions. To meet all needs--domestic, agricultural, industrial, recreational--we shall have to use and reuse the same water, maintaining quality as well as quantity. In many areas we need new sources of supply, but in all areas we must protect the supplies we have." (emphasis added)

Our guiding policy shall then be one of use and reuse, maintaining quality as well as quantity, disturbing ecological relationships as little as possible. "Waters whose existing quality is better than the established standards . . . will be maintained at their existing high quality . . . and . . . will not be lowered in quality . . . " ³

Implementation of objectives

To achieve the objectives stated in the first section, Function, and listed below as 1.0, 2.0, 3.0, 4.0, and 5.0, the Site Permit System requires:

- 1.0--*Prevention of the contamination or alteration in physical property of water as a result of its utilization by either an enterprise or community activity.*
- 1.1--Full disclosure of information must be made concerning planned or probably pollutants emitted by any enterprise or community activity.
- 1.2--This information must be guaranteed by the enterpriser to be accurate within the limits imposed by the "best state of the art."
- 1.3--The information should include the volume, timing, type and composition of the future pollutants, including temperature, dissolved oxygen, fecal coliform density, pH, biochemical oxygen demand, nitrates, phosphates, turbidity, total solids, toxic elements, pesticides, and herbicides; and such other pollutants or classes of information as are

³Western States Water Council Annual Report, 1968, p. 1.

now, or shall in the future be considered important and relevant by the State Department of Health and Environmental Sciences.

1.4--All developing enterprises should measure, adequately describe, and evaluate the hydrologic conditions of their chosen site and surroundings. (The potentially useful measurements are not all reasonably available at the present time.) Nevertheless, the minimum data requirements should include those necessary to the site scheme presented in the section, Methods of Evaluation.

1.5--Evidence that local and community planning efforts have not been ignored must be submitted. In this section, considered written evaluation must be made of the other site and situation factors, such as extant water quality. An attempt must be made to evaluate some of the less tangible site qualities such as existing expectations of water clarity, or amenity related to hydrologic conditions such as smells, turbulence, etc., so that aesthetic degradation does not occur by accident.

2.0--*Working to eliminate present sources contributing to the contamination or alteration in the physical property of water.*

2.1--To insure that an adequate information base exists upon which public knowledge and competent opinion can be formed, all information specified under 1.1 to 1.5 must remain available for public inquiry facilitating the creation of a body of local public opinion capable of achieving hydrologic sanitation.

2.2--Local enterprises must be involved in "roll-back" from water quality standards, before economic growth will be permitted in a polluted area.*

2.3--In order to implement the above, the SPS must notify affected governmental units, agencies and informational media as set forth in the administrative section 1.4.

*The ESPS should prevent any development contributing to the increase in water contaminates, if the records of that region show that the load is up to or above the state quality standards. Any governmental unit, city or county, or planning agency may undertake to provide or have water quality data determined.

This would seem to force polluting industries or activities to decentralize, something the system does not willingly contemplate. It should be noted under general policies that there is also a non-degradation clause intended to discourage the contamination of the few areas which still do have relatively clean water.

3.0--Prevent the mining of water

3.1--A history of the regional watertable must be compiled, demonstrating no recent decline that cannot be clearly attributed to climatic influences on the rates of recharge.

4.0--Provides for a program of recharge in those areas undergoing or that have undergone mining of their water supplies

4.1--No locating enterprise should be allowed to extract additional water until the water table level is again restored and a "safe yield" allocation formula is devised and accepted by the users of the aquifer and/or the water resources agency responsible for the basin unit.

5.0--Deflection of the emplacement of unavoidably dirty industries or other developments considered absolutely unavoidable or inevitable toward those sites at which water quality may be least affected

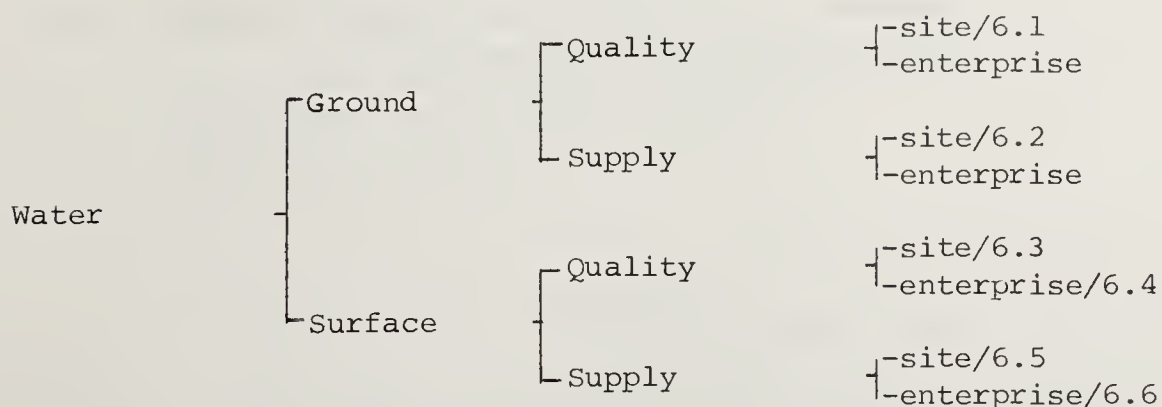
5.1--The potential polluter must be scored according to an index estimate of the damage he might cause.

5.2--In order to compare the estimates of potential damage in the context of site and situation, the following site factors must be evaluated:

- a) existing quality and supply of water
- b) stream flow, lake volume or water table data
- c) potential for pollutant dispersion or dilution.

5.3--It is hoped that the evaluation scheme which follows (6.0) may deflect development to those areas where the consequences of water pollution and/or depletion on individual persons and the public interest will either be diluted or greatly postponed.

6.0--Evaluation



6.1--Groundwater Quality Site
--Groundwater Quality Enterprise

The primary objective of the groundwater quality evaluation in locational control is to make sure that sites are chosen so as to prevent the contamination of aquifers by substances which would render the water unfit for domestic drinking purposes. It recognizes that,

"Pollution that is being added to the ground at one point may not affect the quality of water supply wells at nearby points for many years, or at more distant points for decades; consequently, no complaints are registered and no one may be aware of the damage being done. When pollution is finally discovered or when the quality of water supplies is degraded, the damage cannot be repaired or otherwise rectified merely by stopping the pollution, for purification by leaching and dilution will require a longer time than the period of original pollution."⁴

6.11--All applications shall present evidence demonstrating compliance with existing local, state or county health regulations regarding the disposal of water borne or liquid wastes, including domestic sewage.

6.12--Application for the site permit must be accompanied by certification from a professional hydrologist that onground or underground waste disposal will not transfer contamination beyond a 100 ft. radius of the emission source.

6.13--Contamination Potential Index

Determine the proper index score from Table I and enter on the flowchart at 6.13.

⁴California Water Quality Criteria

Table I

Potential for Contamination	Index
Virtually no chance of contaminants ever reaching aquifers	1
It is highly improbable that contaminants will persist or reach streams or aquifers within 1000 years.	2
There is some chance that contaminants will persist and reach streams or aquifers within 500 years	5
It is certain that contaminants will persist or spread beyond a 100 foot radius to streams or aquifers within 50 years at planned rates of emission	10

6.2--Groundwater Supply, Site

Interpolate Index score for Depletion Potential, between 1 and 10. Enter the score on the flowchart at 6.2.

Table II

Depletion Potential	Index
No detectable effect will result from drawdown or other ground water use.	1
Small changes in surface vegetation, dissolved solids or temperature that can be attributed to water table lowering or water extraction	5
Significant lowering of the regional aquifer will affect other potential users over a ten year time span of normal fluctuations	10

6.3--Surface Water Quality/Site

For the purposes of this evaluation and that of 6.4, the "WQI" developed by Brown, McClelland, Deininger and Tozer, has been adopted. It is felt that this system

provides the clearest, most comprehensive and concise evaluation developed thus far.⁵

The enterpriser shall first determine the field values at the most critical period* for each of the water quality parameters. These are entered under the column, Measured Values. Each measured value shall then be found on their respective parameter curve (Appendix II) with the intersection of the measured value and curve being read on the vertical axis as the water quality index. These values shall then be multiplied by their assigned weights with each result then being summed, resulting in the "WQI" between 1 and 100. This shall then be subtracted from 100 with that result being divided by 10 giving an index for water quality consistent with the rest of the SPS.

Refer to the parameter curves in Appendix II.

⁵Brown, Robert M., Nina I. McClelland, Rolf A. Deininger & Ronald O. Tozer, A Water Quality Index - do we dare?, Water and Sewage Works, Oct. 1970, pp. 339-343.

*The annual fluctuations in temperature, dissolved oxygen, turbidity, etc. exert stresses on the dependent biotic system. In turn the biotic system has periods in which it too is particularly sensitive (eg. spawning, hatching, etc.). It is the interaction of these two areas which determines the most critical period, and will require at least one seasons' data for determination.

Table III

Site "WQI"

Parameter	Measured Value	Indiv. Quality Rating (Q_1)	Weights (W_1)	Overall Quality Rating ($Q_1 \times W_1$)
D. O. percent sat.	_____	_____	0.17	_____
Fecal coliform density lb/100ml	_____	_____	0.15	_____
pH	_____	_____	0.11	_____
BOD ₅ mg/l	_____	_____	0.11	_____
Nitrate, mg/l	_____	_____	0.10	_____
Phosphate mg/l	_____	_____	0.10	_____
Temperature °C departure from equilibrium	_____	_____	0.10	_____
Turbidity, units	_____	_____	0.08	_____
Total solids, mg/l	_____	_____	0.08	_____

$$WQI = \sum W_1 \times Q_1 = \underline{\hspace{2cm}}$$

(sum of the product of
Indiv. Quality Rating
and Weight)

$$SPS \text{ index} = \frac{100 - "WQI"}{10} = \frac{100 - \underline{\hspace{2cm}}}{10}$$

$$SPS \text{ index} = \underline{\hspace{2cm}}$$

6.4--Surface Water/Quality/Enterprise

The function of this evaluation is to determine the quality of water emitted by the prospective enterpriser. This index will then be used in assessment of quality

alteration to ascertain the concomitant degree of change expected in the receptor stream or lake.

6.41--The same procedure is followed here as in 6.3.

Table IV
Enterprise Emissions "WQI"

Parameter	Measured Value	Indiv. Quality Rating (Q_1)	Weights (W_1)	Overall Quality Rating ($Q_1 \times W_1$)
D. O. percent sat.	_____	_____	0.17	_____
Fecal coliform density lb/100ml	_____	_____	0.15	_____
pH	_____	_____	0.11	_____
BOD ₅ mg/l	_____	_____	0.11	_____
Nitrate, mg/l	_____	_____	0.10	_____
Phosphate mg/l	_____	_____	0.10	_____
Temperature °C departure from equilibrium	_____	_____	0.10	_____
Turbidity, units	_____	_____	0.08	_____
Total solids, mg/l	_____	_____	0.08	_____

$$WQI = \sum W_1 \times Q_1 = \underline{\hspace{2cm}}$$

(sum of the product of
Indiv. Quality Rating
and Weight)

$$SPS \text{ index} = \frac{100 - "WQI"}{10} = \frac{100 - \underline{\hspace{2cm}}}{10}$$

$$SPS \text{ index} = \underline{\hspace{2cm}}$$

6.42--Upon completion of the site "WQI" (6.3) and enterprise "WQI" (6.41) locate the derived site index number at its respective position along the horizontal axis and the derived enterprise index number at its respective position along the vertical axis. The intersection of Enterprise "WQI" row and the Site "WQI" column yields the General Index to Water Quality.

Table V

Water Quality Index

Site "WQI"

		Site "WQI"										
		0	10	20	30	40	50	60	70	80	90	100
Enterprise "WQI"	0	0	0	0	0	0	0	0	0	0	0	0
	10	100	1	2	3	4	5	6	7	8	9	10
	20	100	100	4	6	8	10	12	14	16	18	20
	30	100	100	100	9	12	15	18	21	24	27	30
	40	100	100	100	100	16	20	24	28	32	36	40
	50	100	100	100	100	100	25	30	35	40	45	50
	60	100	100	100	100	100	100	36	42	48	54	60
	70	100	100	100	100	100	100	100	49	56	63	70
	80	100	100	100	100	100	100	100	100	64	72	80
	90	100	100	100	100	100	100	100	100	100	81	90
	100	100	100	100	100	100	100	100	100	100	100	100

6.43--Toxic Elements

We face with toxic elements the same problems encountered with the TLV's in the Aerometric Index. We do not have adequate information to determine their combined behaviors (i.e. whether their effects are additive, subtractive, or multiplicative and how these relations vary with the affected organisms). For water evaluation,

the toxic elements have been separated into three categories, 1) inorganic, 2) organic, and 3) radioactive. It is assumed that the effects within each category are additive.

The volume of each toxic element shall be divided by the permissible limit as given in Appendix II with the result then multiplied by 100 to give each emission element as a percent of the permissible limit. The percent of each emission element shall then be added. The sum is then indexed.

Table VI

Organic	Index
Summed percent of outfall/permissible limit at or above 100%	10
Summed percent of outfall/permissible limit between 75% and 100%	7
Summed percent of outfall/permissible limit between 50% and 75%	4
Summed percent of outfall/permissible limit less than 50%	1

Table VII

Inorganic	Index
Summed percent of outfall/permissible limit at or above 100%	10
Summed percent of outfall/permissible limit between 75% and 100%	7
Summed percent of outfall/permissible limit between 50% and 75%	4
Summed percent of outfall/permissible limit less than 50%	1

Table VIII

Radioactivity	Index
Summed percent of outfall/permmissible limit at or above 100%	10
Summed percent of outfall/permmissible limit between 75% and 100%	7
Summed percent of outfall/permmissible limit between 50% and 75%	4
Summed percent of outfall/permmissible limit less than 50%	1

6.5--Surface Water/Supply/Site

The measurement of the amount of available surface water made here, important in its own right, is also required for the assessment of receptor change and the determination of possible depletion.

Volume of Flow (in acre Ft.) of river or stream
from which supplies will be taken _____

Volume of any lake or other impounded waters
(in acre Ft.) from which supplies will be
taken _____

6.6--Surface Water/Supply/Enterprise

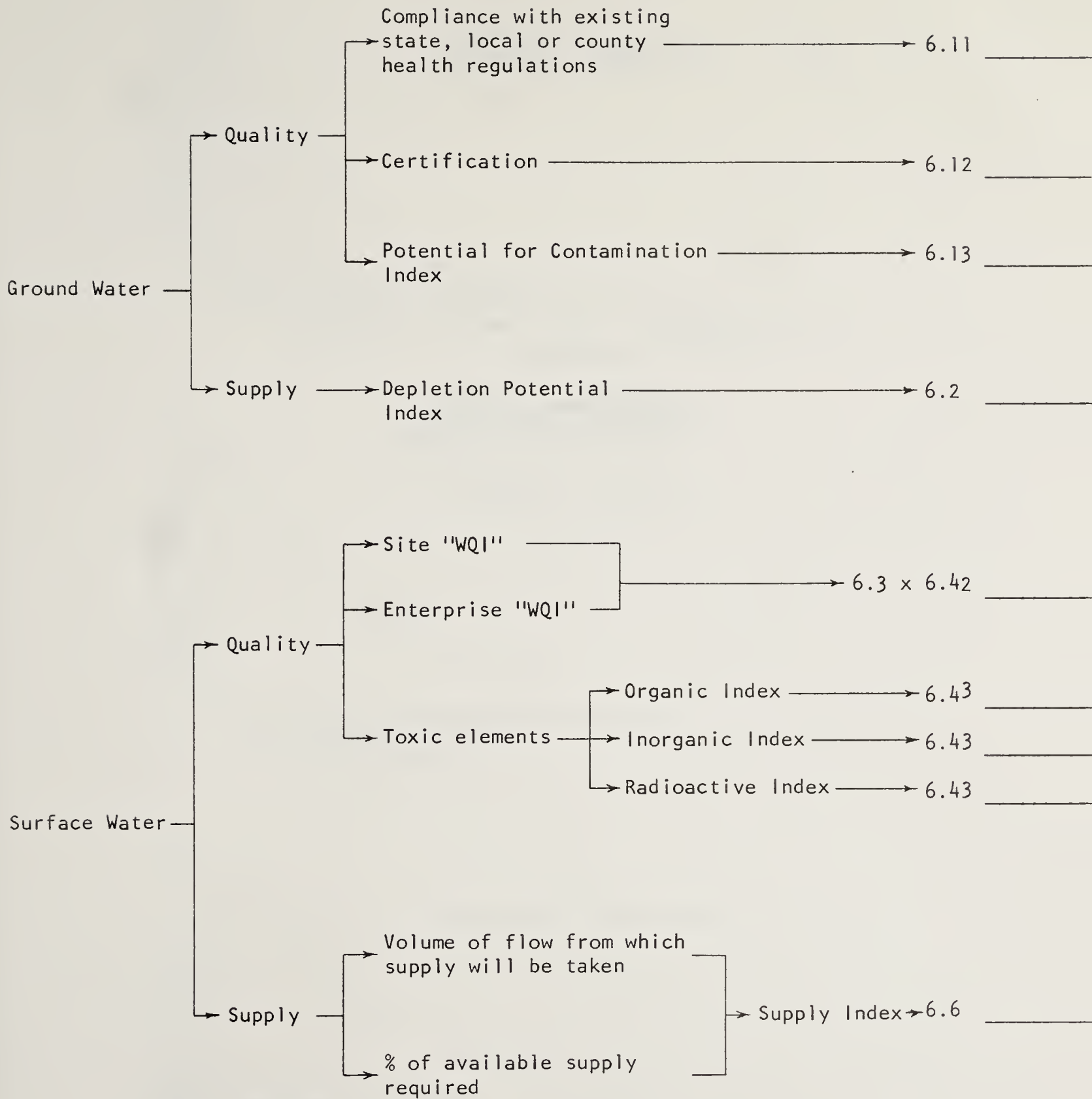
The water requirements of the enterprise in relation to the sites' supply shall be given as percentage of that total supply available.

$$\left[\frac{\text{Enterprise Requirement}}{\text{Site Supply}} \times 100 \right]$$

Table IX

Surface Water/Supply/Site	Index
Surface Water/Supply/Enterprise	
Enterprise requires less than 1% of available flow at critical period (i.e. period of least flow or lowest water) - - - - -	1
Enterprise requires less than 5% but more than or equal to 1% of the available flow at critical periods - - - - -	3
Enterprise requires less than 15% but more than or equal to 5% of the available flow at critical periods - - - - -	7
Enterprise requires more than 15% of the available flow at critical periods - - - - -	10

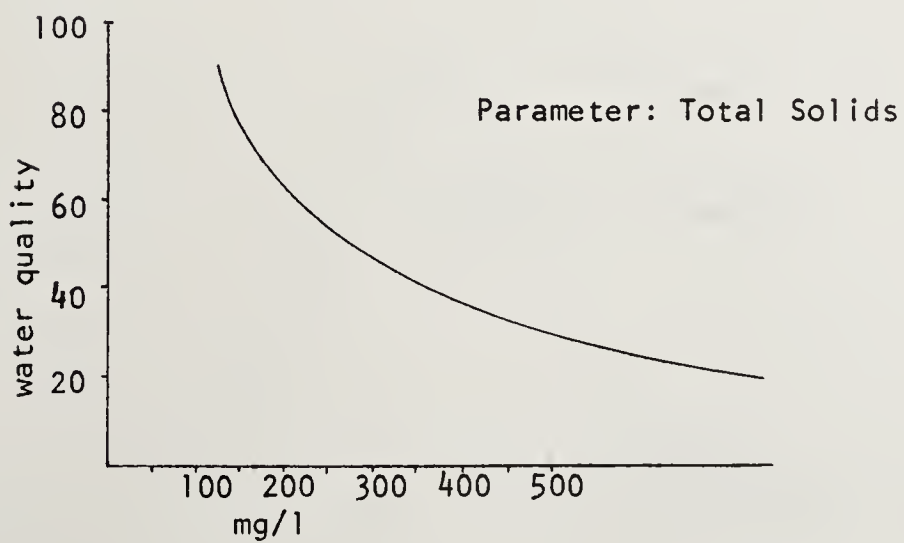
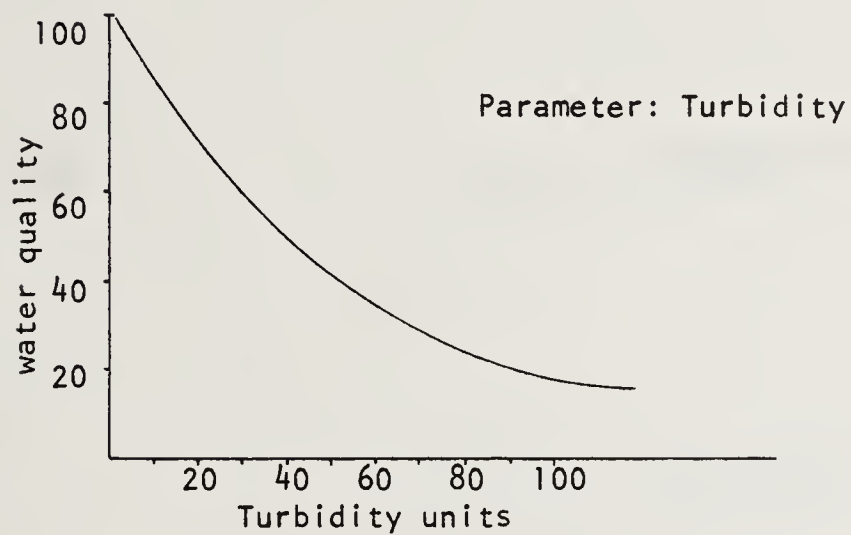
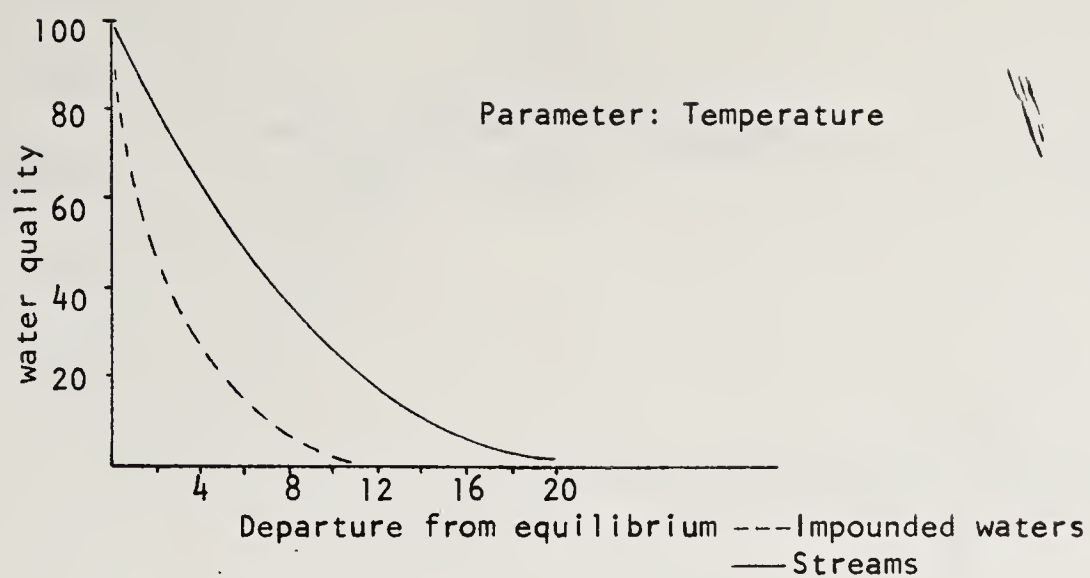
HYDROLOGIC FLOWCHART

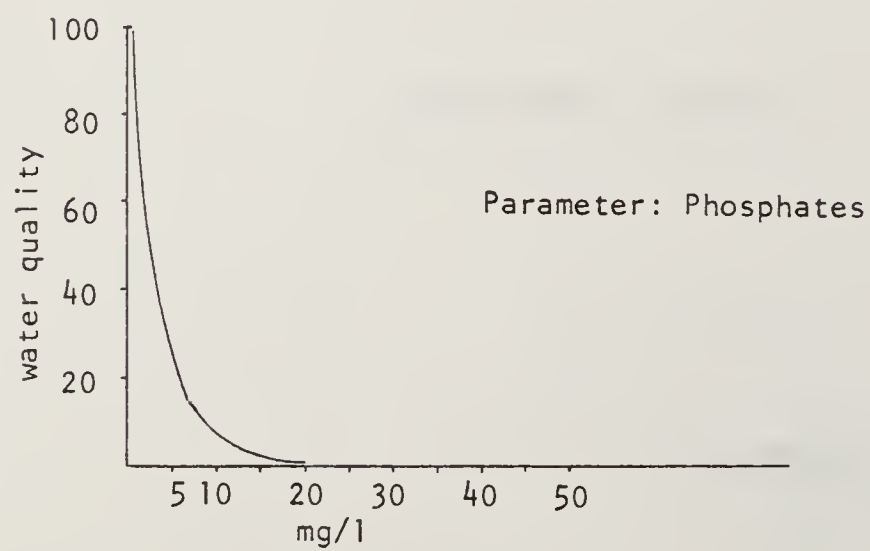
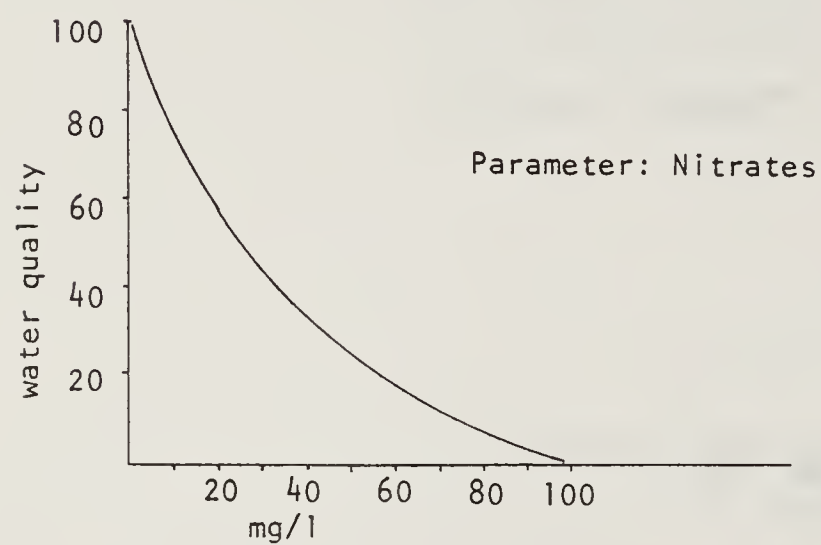
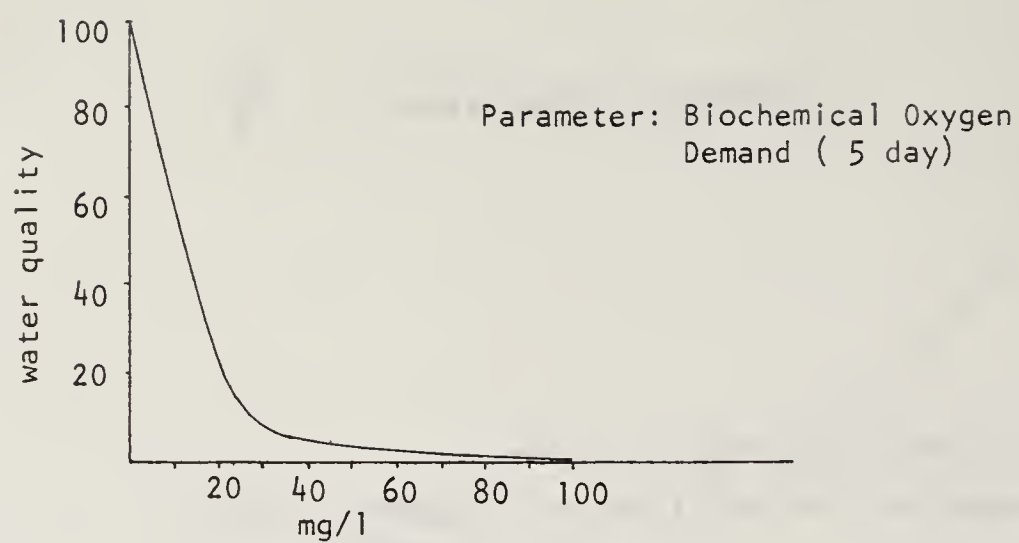


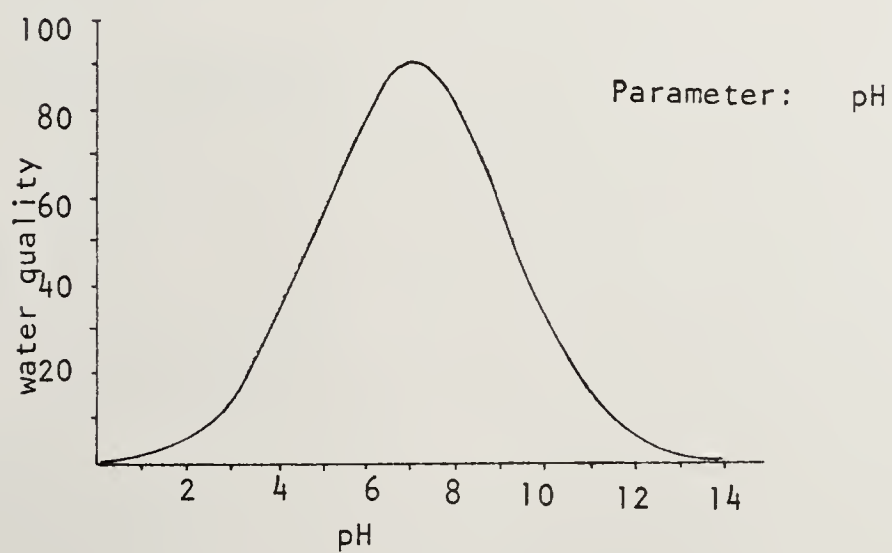
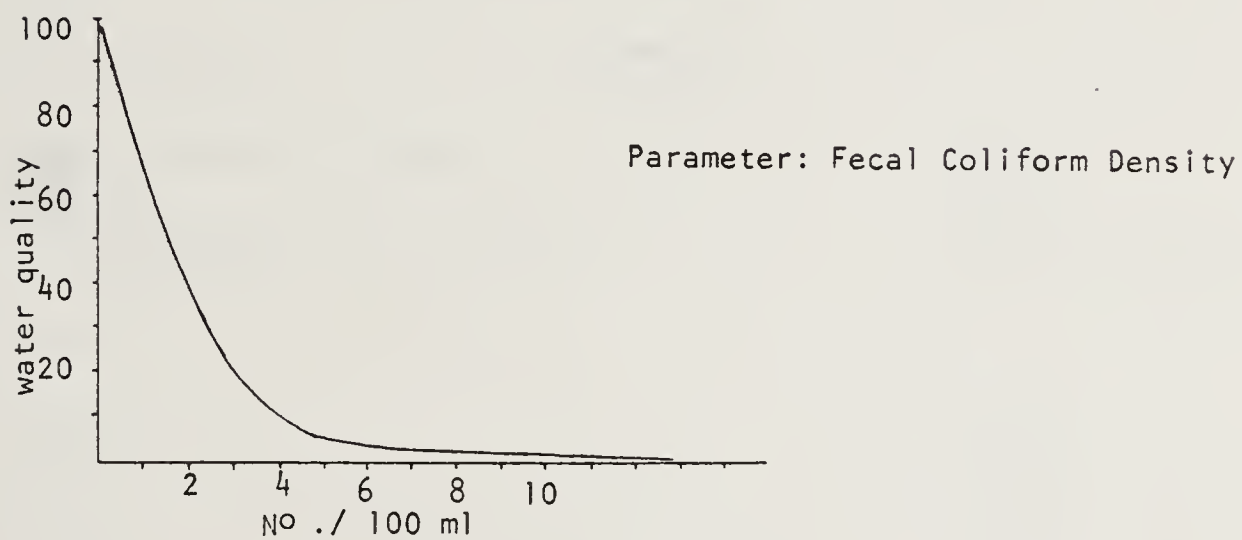
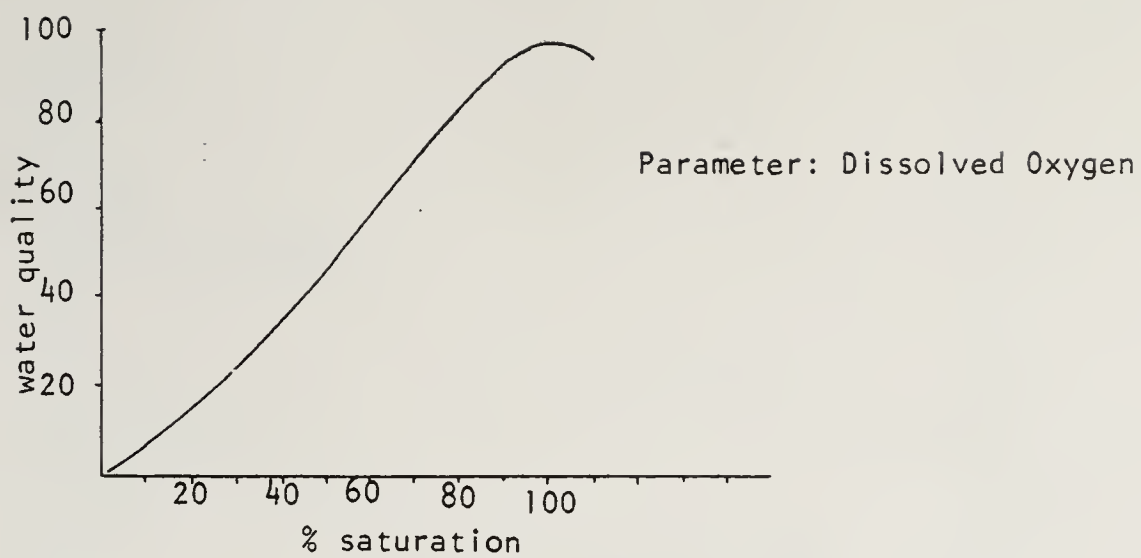
APPENDIX I

Surface Water Criteria
for Public Water Supplies*

*Report of the Committee on
Water Quality Criteria, Federal
Water Pollution Control
Administration, U.S. Dept. of
the Interior







Water Quality Index
Parameter Curves

APPENDIX

II

Inorganic Chemicals:

	mg/l
Ammonia	0.5 (as N)
Arsenic	0.05
Barium	1.0
Boron	1.0
Cadmium	0.01
Chloride	250
Chromium hexavalent	0.05
Copper	1.0
Iron	0.3
Lead	0.05
Manganese	0.05
Nitrates plus Nitrites	10 (as N)
Selenium	0.01
Silver	0.05
Sulfate	250
Total dissolved solids	500
Uranyl ion	5
Zinc	5

Organic Chemicals:

Carbon chloroform extract	0.15
Cyanide	0.20
Methylene blue active substances	0.5
Oil and grease	Virtually absent

Pesticides:

Aldrin	0.017
Chlordane	0.003
DDT	0.042
Dieldrin	0.017
Endrin	0.001
Heptachlor	0.018
Heptachlor epoxide	0.018
Lindane	0.056
Methoxychlor	0.035
Organic phosphates plus carbamates	0.1
Toxaphene	0.005

Herbicides

2,4-D plus 2,4,5-T, plus 2,4,5-TP	0.1
--------------------------------------	-----

Phenols	0.001
---------	-------

Radioactivity	pc/l
---------------	------

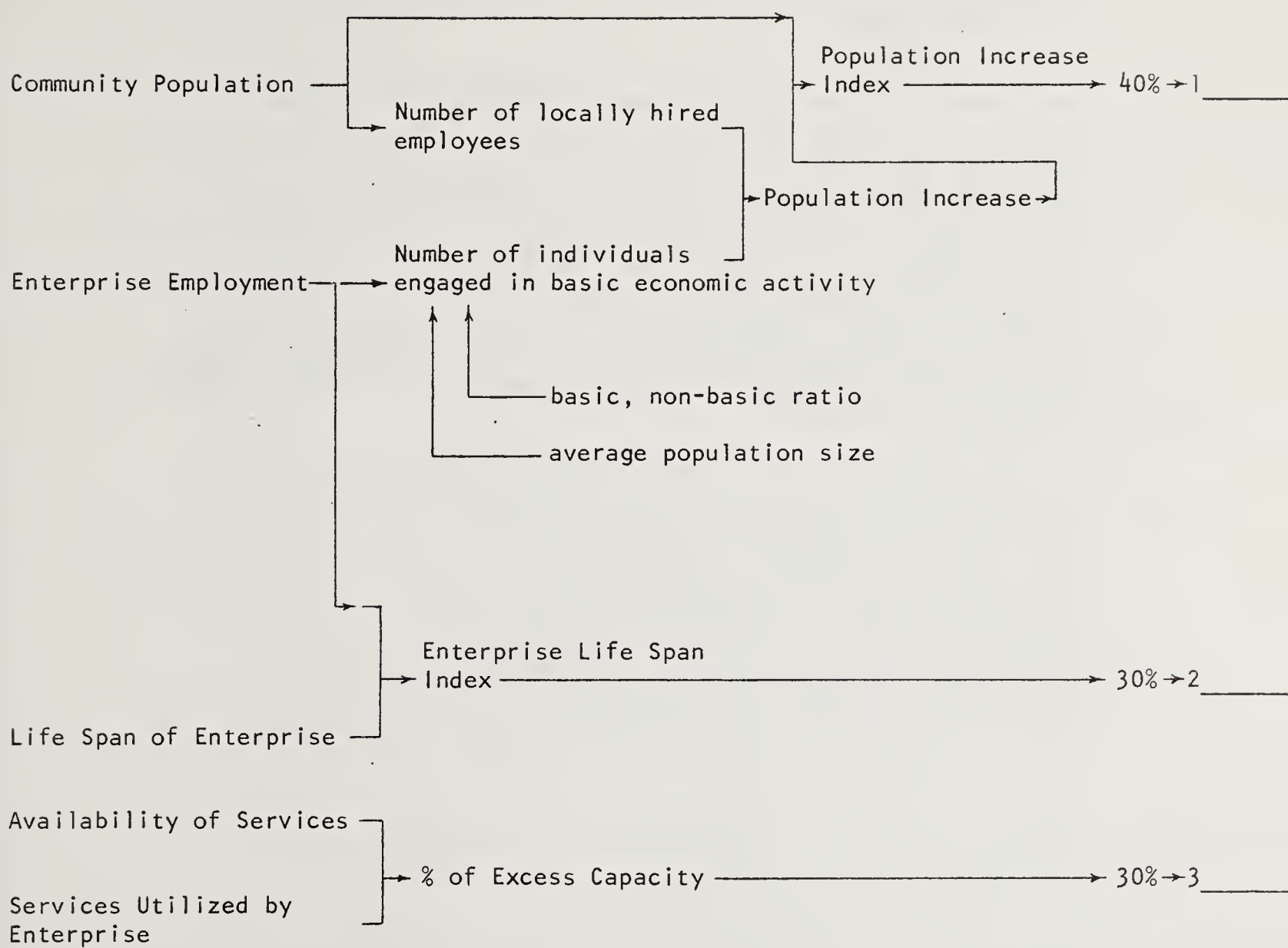
Gross beta	1,000
Radium - 226	3
Strontium - 90	10

SOCIAL COSTS

The good possibilities that may
lie ahead are only those that we
will make ourselves, by a wiser
and more generous and more
exacting use of what we have left.

Wendell Berry, The Long Legged
House, 1965

SOCIAL COSTS FLOWCHART



SOCIAL COSTS

1.0 Rationale

For many, the term "environment" has come to connote our natural heritage (air, land, water, wilderness, and wildlife). If "environment" is limited to physical parameters, it is denied useful breadth as an operating and realistic concept. Since loss of habitat affects all aspects of human systems, an Environmental Site Permit System must be concerned with both the social and the physical costs of location.

1.1 Definitions

A traditional definition of social cost, "the operations of firms or the doings of ordinary people [which] frequently have significant effects on others, of which no account need be taken by the firms or individuals responsible for them"¹ is far too broad for ESPS analysis. Many of the considerations one would normally expect to find in an assessment of social costs are taken into account in other portions of the Site Permit evaluation. Other indicators of social cost no doubt exist, but the discovery of them and the details of their analysis will require long and expensive study. For the purposes of a state level Site Permit System, social costs should probably be considered at the scale of the community or region, not at the level of an individual's welfare or prosperity.

In the Site Permit System, social costs are defined as those consequences of enterprise location which cannot be absorbed by the community without disruption. Disruption is basically an increase in or a cause of community dysfunction. Although not the cause of all community problems, rapid population change is one of the most apparent and easily measured indicators of potential community disruption. Population changes are immediately reflected in the demands placed upon the services provided by the community. For example: an increase in the number of children places a greater burden on the school system. Increased use of and demand for roads results in greater maintenance and construction cost. Loss of potential jobs may result in further in-migration which may then cause an increase in welfare load. Even a slight increase in crime rate may result in a perceived need for more law enforcement.²

¹ E. J. Mishan, *The Cost of Economic Growth*, F.A. Praeger, N.Y and Washington, 1967, p.53.

² For example, see "Impact of Libby Dam Construction in Lincoln County, Montana", John Wicks, John M. Griffing, E.M. Hutchinson, Bureau of Business and Economic Research, University of Montana, Missoula, Nov. 1969.

Developmental impacts usually create a demand for greater investment in the public sector. Although this is not necessarily bad, the usual result is a temporary reduction in the quality of services for varying lengths of time and greater costs, direct or indirect, to the people of the community. Even so, economic investment in the public sector may not be the most important factor in the social costs of enterprise location. Unforeseen and unwanted environmental consequences frequently ensue from transitory, ill-conceived, or poorly located enterprises.³ A progressive refinement of definition through use of SPS will, hopefully, improve the use of "disruption" as an indicator of social costs.

1.2 Evaluation of costs

The identification and evaluation of the social costs that derive from "enterprise location" is not something easily quantified. The difficulty of assigning dollar values to the social costs to be incurred by the host community⁴ has usually allowed new enterprise to ignore most environmental and public costs of development. Businesses have tended to obscure these costs under the cover of real or imagined "benefits".⁵ Conventional economic analysis has operationally relegated such costs to the category of "externalities", as though the enterprises involved with development were not also dependent on the life of a community. (Some economists have developed models for "internalizing externalities"; use of these models, however, has been limited.) These difficulties are not valid excuses for either ignoring or considering social costs to be irrelevant. Since an enterprise is likely to have some impact upon the long term options and quality of living in a community, then some way can be found to indicate, at least, the magnitude and direction of that impact. This evaluation does not attempt to be a thorough sociological, ecological, or even economic investigation. The method used points out some sensitive indicators of potential inadequate matchings between enterprise, site, and community situation. This section of the evaluation, therefore, is based on a few major indicators of potential social cost.

³For example, a speculative shopping center built on the cheaper land of an urban fringe, could easily cause traffic increases which would persuade municipal management to extend the public investment in roads and utilities. Accompanying urban sprawl thus facilitated might not only spoil forever larger quantities of good land, and urban open space options; but might also, by shifting traffic in population centers, bring about a chain of consequences ranging from accelerated decay of the inner city to overburdening of sewage disposal facilities, decrease in ambient air quality, or loss of urban uniqueness and identity.

⁴The community is that municipality in which the majority of the enterprises' employees reside and upon which the enterprise will normally have the greatest impact. (e.g., Missoula would be the community for Hoerner-Waldorf, and Garrison that for Rocky Mountain Phosphate Co.).

⁵For example, see "Pollution Problems, Resource Policy, and the Scientist", Alfred W. Eippen, Science, 3 July 1970, Vol. 169, No. 3940, pp. 11-20, especially p. 13, typical attitudes of polluters.

1.3 Social benefits

For several reasons, this evaluation makes no attempt to assess the social benefits of enterprise location in a community. First the relative importance of social costs and benefits resulting from individual enterprises rests heavily with social cost. The social cost of enterprise location tends to be borne or postponed to the future by the general public or by the environment, while the benefits may accrue rapidly to a relatively small number of people in the community. Secondly, enterprise has traditionally promoted the benefits of their location in a community. This behavior will probably continue, and is wholly compatible with the basic assumption made earlier: "that the society is best served by a diversity of enterprise that calculates benefits and makes initial location choices from premises and motives outside the government." The SPS simply makes it more difficult to ignore the costs of enterprise location at a particular place. Thirdly, the manner in which the Site Permit evaluations are constructed makes it impractical to award positive points. A score of zero signifies a neutral or favorable match between enterprise, site and situation. Thus, in terms of the system, positive or beneficial index points are superfluous.

2.0 Scoring System

It is felt that indicators of disruption potential reflect in a most general and straight-forward manner the possibility of an inadequate matching between enterprise, site, and the community situation. Potential disruption can be indicated by:

- 1) the amount of population growth attributable to the location of an enterprise in the community, in relation to the size of that community;
- 2) the size of the enterprise in relationship to the probable lifespan of that enterprise; and
- 3) the quantity of public services utilized by the enterprise in relationship to the ability of the service(s) to absorb the increase in use without expansion of presently available facilities (i.e., services used in relationship to the unused capacity of these services).

These parameters are not measured in dollar terms. As noted previously, generation of monetary impact figures is difficult and expensive. Relative indexing of disruption can be accomplished by the assignment of points to percentage figures generated from the above-mentioned parameters.

3.0 Relative magnitude of the enterprise in relationship to that of the community (40 of 100 points).

Location of an enterprise in a community has a potential for disruption that depends upon the size of the enterprise in relationship to the size of the community into which it is moved. For example, an enterprise employing 50 people would have a much greater effect upon a community of 500 than it would upon a community of 50,000. The number of locally hired employees is subtracted from the gross expected population increase so as not to penalize the enterprise for the hiring of people already resident.

Because increased population is the major and certainly the most easily measured cause of disruption, this section of the evaluation system was given 40% of the total. Schools, fire protection, law enforcement, welfare, hospitals, city and county government must expand roughly according to the growth in population. Expansion, and/or a reduction in the quality of services entails costs which are borne by all the people and are thus social costs. Rarely in the long run, and never in the environmental sense, do the increased taxes paid by the enterprise or its employees compensate equitably for such costs. Traditionally, it has been felt that this deficit was overcome by the "beneficial" increase in business and jobs. This view is no longer sufficient. (Development for the sake of continued growth can no longer be considered a valid reason for development.) The public has been only dimly aware of the hidden costs of enterprise location in their communities. The Site Permit System cannot hope to point out each and every hidden cost for every possible future enterprise that may be developed in, or attracted to Montana. However, the concept and purposes of the Site Permit System make it necessary to consider social costs as a part of the decision-making process in "enterprise location" choice.

3.1 Commentary

It may be argued that this portion of the system tends to encourage enterprises to locate only in developed areas, thus simply increasing their problems while at the same time discouraging growth of "underdeveloped" areas. This argument is valid. The benefits of agglomeration, however, strongly attract enterprise. Thus, most enterprises will probably tend to locate in a larger community anyway. The location of an enterprise in an undeveloped area is likely to be the result of a special resource characteristic (e.g., environmental amenities; an ore body), or special intervention (e.g., government incentive). The potential for disruption that adheres to the large enterprise moving into the small community is too substantial a factor to ignore. Such disruption is usually not overbalanced by the benefits conferred upon the community. In addition, the dangers of disruption are compounded by the disproportionate political power traditionally held by a locally dominant enterprise. Under such circumstances, environmental preservation as well as economic options tend to be highly limited.

Although there are many other social costs connected with population increase and enterprise location, they are difficult to assess. Several methods, including cost-benefit analysis were attempted. None of them were deemed feasible for the operation of a Site Permit System. The evaluation of other social costs, such as disruption of the social fabric; change in age ratios; or even the increases in demands for technical education, will have to be indirectly measured or compensated for in some other way.

3.2 Scoring

The determination of the number of points received from this portion of the evaluation process is made in the following manner: the number of employees engaged in basic economic activity⁶ is multiplied by 2.4, the basic non-basic ratio.⁷ This product is then multiplied by the average family size of Montana (in 1970 this was 3.6)⁸ Subtract from this product the number of locally hired employees times the average family size. The difference should then be an estimate of the population increase which can be attributed to the locating enterprise. To determine the number of index points the enterprise may receive from this section, present population of the community is divided by the population increase. One point is received for each percent of increase.

The following formula, a restatement of the above, may be used:

$$\frac{[(E \times 2.4) \times 3.6] - (LE \times 3.6) \times 100}{\text{Present community population}} = \% \text{ population change}$$

Percent of Population Change = index points (1 point is received for each percentage point of change)

where: E_b equals number of employees engaged in basic economic production (i.e., the production of goods intended for export as opposed to those produced for local consumption) employed by the enterprise under evaluation.

2.4 = the presently accepted basic non-basic ratio, meaning the number of non-basic jobs created by one basic employment position.

LE = local residents hired to basic economic employment;

$(E \times 2.4)$ = number of basic and non-basic jobs created by the enterprise;

$[(E_b \times 2.4) \times \text{ave. fam. size}]$ = total no. of individuals and their families supported directly by the basic economic activity (gross population increase);

$(LE \times 3.6)$ = total no. of locally hired residents engaged in basic economic activity plus their families;

$[(E_b \times 2.4) \times 3.6] - (LE \times 3.6)$ = evaluative population increase for the community (net population increase).

⁶"Firms and individuals serving markets outside the community" The Community Economic Base Study, Charles M. Tiebout Supplementary Paper No. 16 Committee for Economic Development, December 1962, p. 13

⁷Montana Economic Study, Part I, Vol. I, Chap. I. Bureau of Business and Economic Research, University of Montana, Missoula, Mont, 1970, p. 1.89.

⁸St. Dept. of Planning & Economic Devel., St. Info. System, computed from 1970 Census data.

If there are no basic employees (E_b) then:

1. Multiply the number of non-basic employees (E_{nb}) time 3.6 ($E_{nb} \times 3.6$) which equals the gross population increase;
2. The number of locally hired employees (LE) is multiplied by 3.6 ($LE \times 3.6$).
3. The result of this operation is subtracted from the gross population increase [$E_{nb} \times 3.6$] - [$(LE \times 3.6)$] which equals the net population increase.
4. The result of this operation, divided by the present community size and multiplied by 100 equals the percentage of population change.

$$\frac{[(E_{nb} \times 3.6)] - [(LE \times 3.6)] \times 100}{\text{Present community population}} = \% \text{ of population change}$$

4.0 Size of Enterprise vs. Life Span of the Enterprise (30% of 100 points)

This second index of disruption is related to the first. Without the tempering aspects of time, the difficulties of increasing population are compounded by a short life span of enterprise. Over a period of years, the effects of enterprise location on a community are usually absorbed or adapted to. When the opportunity for this to take place is reduced, the potential for disruption is much greater.

The larger the size of an enterprise and the shorter its life span, the greater is its potential for disruption. When changes are introduced by short term enterprises, communities usually take only minimal measures to provide for what they may view as a temporary increase of social cost. On the other hand, damage and change to the environment may occur before the community is aware and capable of taking action to constrain or repair the problem. Or, if adequate measures are taken to reduce the social costs, the sudden withdrawal of the enterprise may produce a financial and service crisis in the community.

4.1 Lifespan

Expected Enterprise Life Span in Years

No. of		1	1-3	3-7	7
Full	200	100	80	60	30
Time	199-70	90	70	40	20
Empl.	69-15	60	40	20	10
	14-5	30	10	0	0
	5-1	20	0	0	0

To determine the number of points, find the number of full time employees in the appropriate row; then read to the right until the appropriate column is reached. The number in the box is the total of index points received. For example, if the number of employees is 10 and the expected life span of the enterprise is less than 1 year, it receives 30 points.

5.0 Public Services Utilized vs. Amount of Excess Capacity of Those Services (30 of 100 points).

The basic assumption of this section is: the potential for disruption increases as an enterprise approaches the point of forcing the community to expand presently available services. Although enterprises pay taxes to support services they may not use, the service demands of the enterprise and its employees are not always fully met by its non-tax contributions. In the short term, developmental costs of services (e.g., water and sewage) are not paid for, either by present or future tax contributions. Public services, for the purposes of this section, are those services provided by either city or county governments as well as those provided by 'investor owned' public utilities or co-ops.

5.1 Rationale

Development of services and utilities of this sort makes environmental demands. Developing the capacity to deliver power, whether thermal or hydroelectric, inevitably results in environmental disturbances, only some of which fluctuate in proportion to the loads on the system. A similar situation applies to water supplies. Unless specifically designed for the purposes of attracting industry, the normal trend at the community level is a lagging development of utilities, health services and waste treatment plants in a step-by-step fashion, considering only extant demand and short term growth forecasts. The normal sequence of development involves the first use of the most immediate and cheaply available high grade fuels, accessible water, and most convenient waste disposal systems. Evidence of long term consideration of the environmental consequences that result from the development of these services by either community or enterprise is lacking. Each successive level of short term service development probably results in higher aggregate environmental and fiscal costs. Therefore, it is necessary for communities desiring growth to plan and invest in their services with long term environmental and social considerations in mind. It is disruptive and, in a sense exploitative, for a newly arrived enterprise to expect a community to incur extraordinary investment costs, increased "units of services" prices, and loss of its environmental options or advantages.

5.2 Commentary

The likelihood exists, however, that the additional service demand of an incoming enterprise could create a situation in which a new service could at last be considered economically feasible. Documentation of such a situation should be invited. The situation of many towns presently without sewage processing is a case in point. Even under these conditions it is still necessary that the enterprise consider the potential social costs of its location in that community. It is quite likely that under such circumstances the obligation would be willingly undertaken by the community in advance of and in expectation of the contributions of the enterprise. Although development is often necessary, the environmental change possible in either situation justifies indexing and scoring.

5.3 Scoring

One point is received for each percent of unused capacity in each of all the services utilized by the enterprise. If, for example, the community's water system could supply 100,000 gals. per day more than the present demand without expansion of the present basic system, and an enterprise would use 50,000 gals. per day, the enterprise would be using 50% of the excess capacity. It would, therefore, receive 50 points. This procedure is followed for all services used. All computations of excess capacity should be made at the time of shortest supply or maximum demand. These points are added together to obtain the total number of index points for this section. This total constitutes 30% of the whole social cost evaluation scheme.

Enterprise should evaluate itself with respect to: water supply, power or other energy supply, sewage system treatment capacity, adequacy of local transport network investment, solid waste disposal system, and communication system sufficiency. Health facilities, schools, and the demand for fire protection must be evaluated separately and directly as special circumstances or hazards dictate.

6.0 Total Score

The total score for this section is determined in the following manner:

6.1 Take 40% of the index number obtained in part 3.2,

6.2 Take 30% of the index number obtained in part 4.1,

6.3 Take 30% of the index number obtained in part 5.3.

Add together the results of the above operations.
The sum is the total award for the Social Costs portion of the Site Permit System. Enter on the summary page.

Social Costs Summary

PART 3.2

- Line 1. Percent of employees engaged in basic economic activity expressed in number of employees. (enter here) _____
2. Line 1 multiplied by 2.4 = _____
3. Line 2 multiplied by 3.6 = _____
4. a) Number of local employees _____
 b) Line 4a multiplied by 3.6 _____
 c) Subtract line 4b from Line 3, enter result _____
5. Enter local population _____
6. Divide Line 5 into Line 4c, enter result _____
7. Multiply Line 6 by 100. Result equals index number for this section _____

PART 4.1

EXPECTED LIFE SPAN OF THE ENTERPRISE IN YEARS					
No.	200	1	1-3	3-7	7
of	199-70	90	70	40	20
Empl.	69-15	60	40	20	10
	14-5	30	10	0	0
	5-1	20	0	0	0

- Line 1. Find appropriate category for number of employees in the column listed above.
2. Read to right until appropriate row for expected lifespan is reached.
3. Box score is the index number for this section (enter here) _____

PART 5.3 Repeat the procedure given below for each service used. (as a whole number in the appropriate measure)

- Line 1. Enter the unused capacity of service _____
2. Enter your consumption of or contribution to use of this service _____
3. Divide Line 1 into Line 2 (enter here) _____
4. Multiply Line 3 by 100 (enter here) _____ = % of unused capacity to be consumed.
5. Add together for all services used. This sum is the index number for this section (enter here) _____

TOTAL SCORE, PART 6.0

- Line 1. Part I: Take 40% of Line 7. (enter here) _____
2. Part II: Take 30% of Line 3. (enter here) _____
3. Part III: Take 30% of Line 5. (enter here) _____
4. Add results of Lines 1, 2, 3, of Total Score Section. (enter here) _____

Line 4 is the total award for the Social Cost Section of the Site Permit System.

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